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(12) **United States Patent**
Hara et al.

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(54) **WIRELESS COMMUNICATION TERMINAL AND WIRELESS COMMUNICATION TERMINAL CONTROL METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 572 days.

(21) Appl. No.: **12/628,745**

(22) Filed: **Dec. 1, 2009**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 12/359,315, filed on Jan. 24, 2009, now abandoned.

(30) **Foreign Application Priority Data**

Jan. 23, 2009 (JP) 2009-013553

(51) **Int. Cl.**

H04W 4/00	(2009.01)
G08C 17/00	(2006.01)
H04H 20/67	(2008.01)
H04W 48/16	(2009.01)
H04W 8/22	(2009.01)
H04W 64/00	(2009.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04W 48/16*** (2013.01); *H04W 8/22* (2013.01); *H04W 64/00* (2013.01); *H04W 84/12* (2013.01); *H04W 88/06* (2013.01)

(58) **Field of Classification Search**

CPC H04W 48/16; H04W 8/22; H04W 64/00
USPC 370/311, 328, 329, 338; 455/161.1, 455/435.1, 456.1, 552.1
See application file for complete search history.

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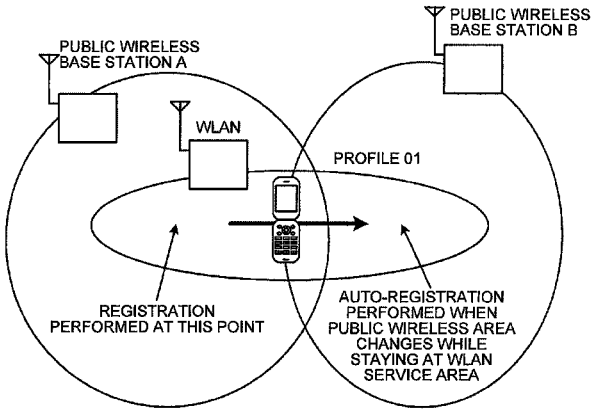
(57) **ABSTRACT**

A mobile phone terminal receives current position information thereof from a public wireless base station, and stores the current position information. The mobile phone terminal reads a profile name corresponding to the position information from a public wireless base station-WLAN profile association table, and sets the WLAN profile as a scan profile. Then, the mobile phone terminal scans the WLAN profile when the mobile phone terminal is located outside the WLAN service area.

2 Claims, 20 Drawing Sheets



(51) **Int. Cl.**
H04W 84/12 (2009.01)
H04W 88/06 (2009.01)

(56) **References Cited**

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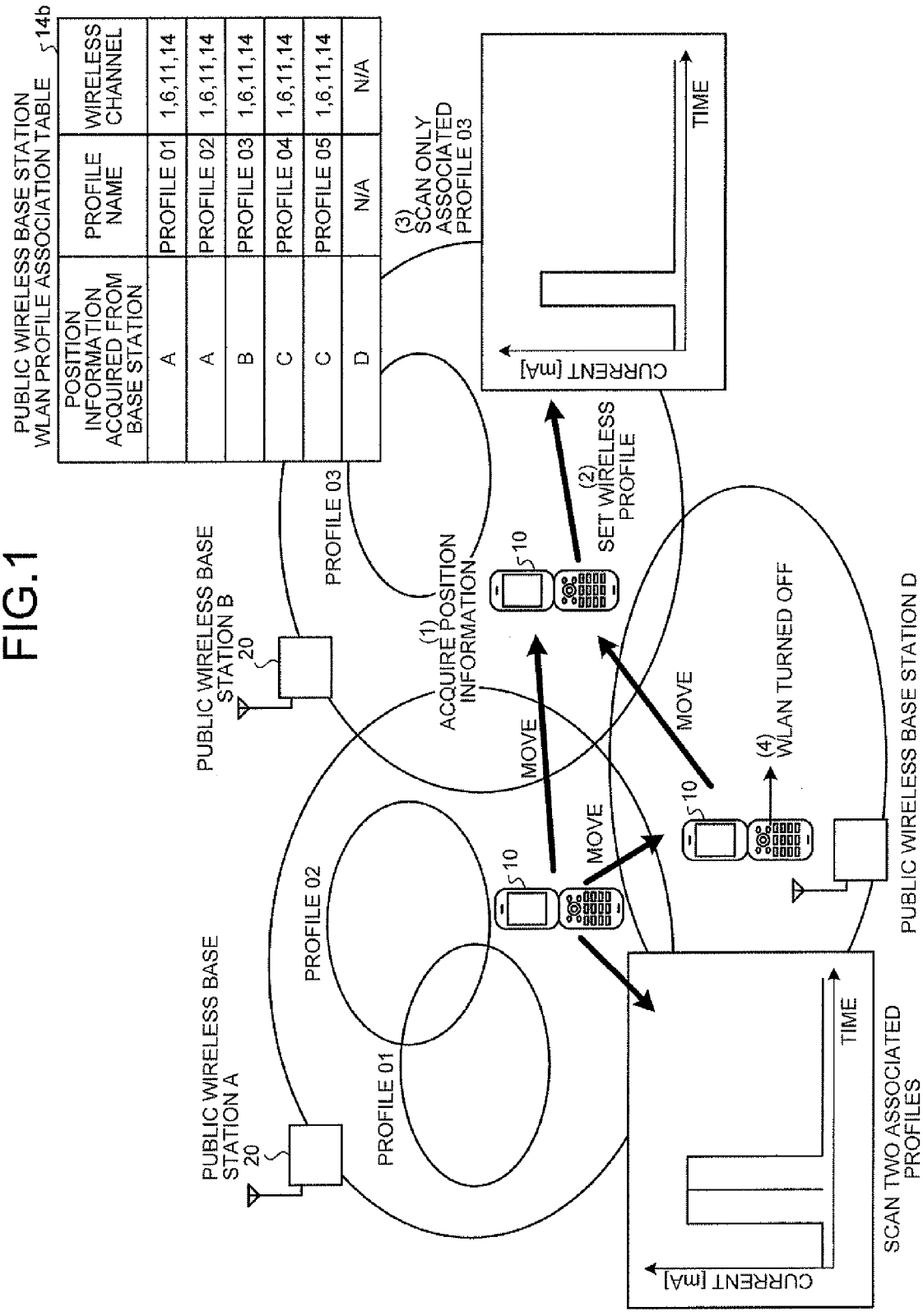
FIG.1



PUBLIC WIRELESS BASE STATION WLAN PROFILE ASSOCIATION TABLE 14b

POSITION INFORMATION ACQUIRED FROM BASE STATION	PROFILE NAME	WIRELESS CHANNEL
A	PROFILE 01	1,6,11,14
A	PROFILE 02	1,6,11,14
B	PROFILE 03	1,6,11,14
C	PROFILE 04	1,6,11,14
C	PROFILE 05	1,6,11,14
D	N/A	N/A

FIG.2

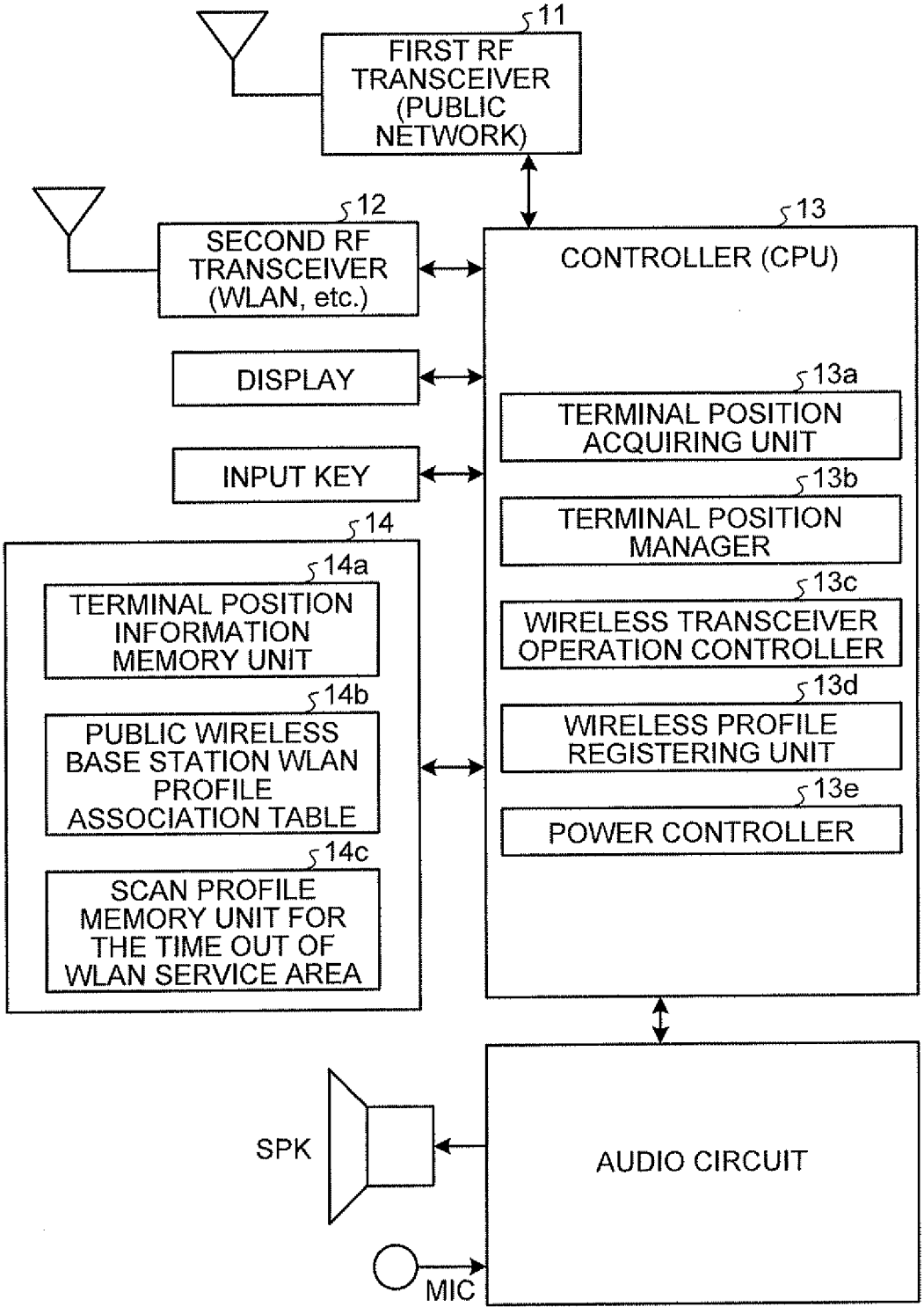

11
FIRST RF TRANSCEIVER (PUBLIC NETWORK)
12
SECOND RF TRANSCEIVER (WLAN, etc.)
13
CONTROLLER (CPU)
DISPLAY
INPUT KEY
13a
TERMINAL POSITION ACQUIRING UNIT
13b
TERMINAL POSITION MANAGER
13c
WIRELESS TRANSCEIVER OPERATION CONTROLLER
13d
WIRELESS PROFILE REGISTERING UNIT
13e
POWER CONTROLLER
14
14a
TERMINAL POSITION INFORMATION MEMORY UNIT
14b
PUBLIC WIRELESS BASE STATION WLAN PROFILE ASSOCIATION TABLE
14c
SCAN PROFILE MEMORY UNIT FOR THE TIME OUT OF WLAN SERVICE AREA
SPK
AUDIO CIRCUIT
MIC

FIG.3

POSITION INFORMATION ACQUIRED FROM BASE STATION	PROFILE NAME	WIRELESS CHANNEL SETTING
A	PROFILE 01	Auto (1,6,11,14)
A	PROFILE 02	Auto (1-14)
B	PROFILE 03	Auto (1,6,11,14)
C	PROFILE 04	Auto (1,6,11,14)
C	PROFILE 05	Auto (1-14)

FIG.4

EXAMPLE OF SCAN PROFILE FOR TIME OUT OF WLAN SERVICE AREA

POSITION INFORMATION ACQUIRED FROM BASE STATION	PROFILE NAME
A	PROFILE 01
A	PROFILE 02

FIG.5

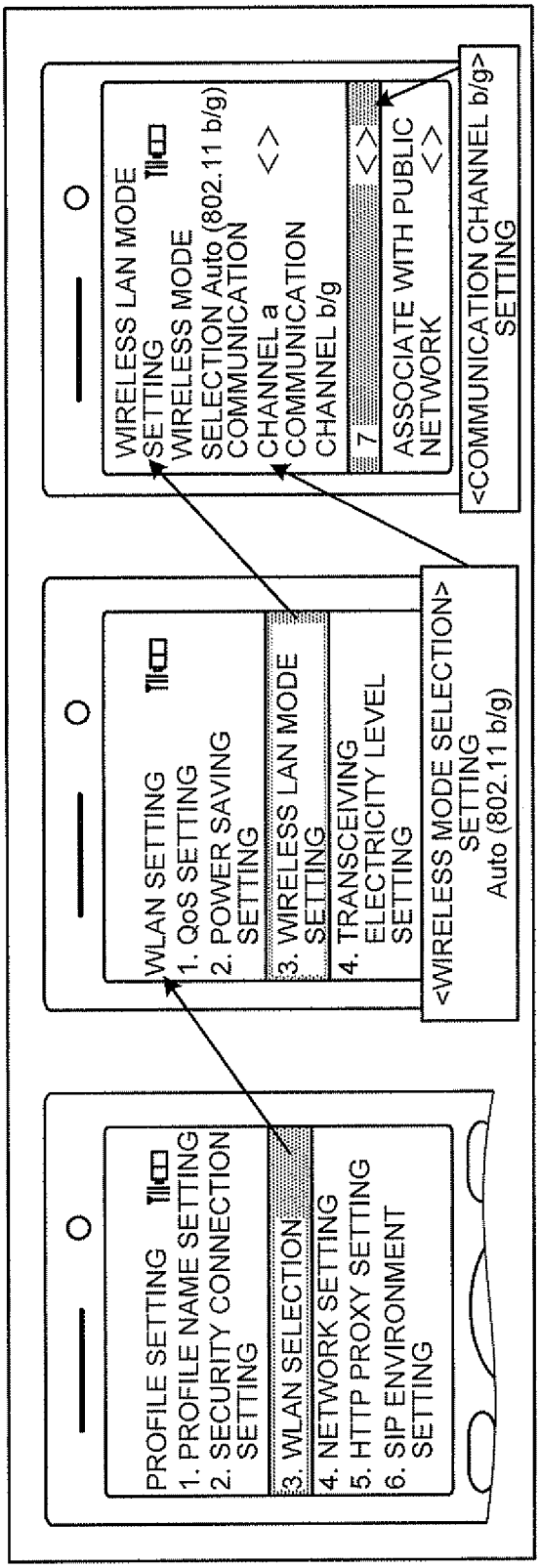

PROFILE SETTING
1. PROFILE NAME SETTING
2. SECURITY CONNECTION SETTING
3. WLAN SELECTION
4. NETWORK SETTING
5. HTTP PROXY SETTING
6. SIP ENVIRONMENT SETTING
WLAN SETTING
1. QoS SETTING
2. POWER SAVING SETTING
3. WIRELESS LAN MODE SETTING
4. TRANSCEIVING ELECTRICITY LEVEL SETTING
<WIRELESS MODE SELECTION> SETTING Auto (802.11 b/g)
WIRELESS LAN MODE SETTING
WIRELESS MODE SELECTION Auto (802.11 b/g)
COMMUNICATION CHANNEL a
COMMUNICATION CHANNEL b/g
7
ASSOCIATE WITH PUBLIC NETWORK
<COMMUNICATION CHANNEL b/g> SETTING

FIG.6

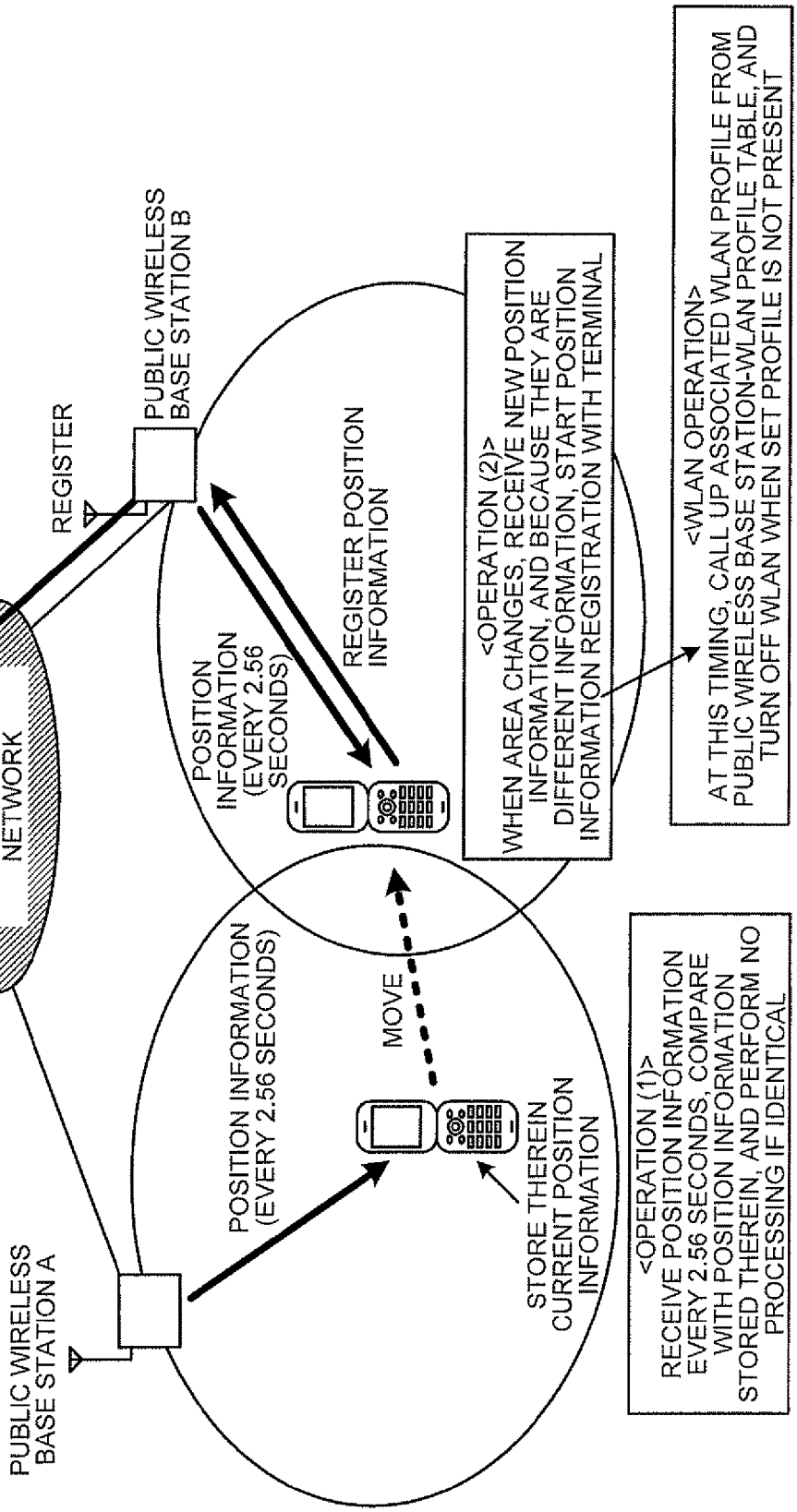

DATABASE FOR PERSONAL COMMUNICATION SERVICE CONTROL (PUBLIC WIRELESS)
REGISTER
PUBLIC WIRELESS BASE STATION B
PUBLIC WIRELESS NETWORK
REGISTER POSITION INFORMATION
POSITION INFORMATION (EVERY 2.56 SECONDS)
<OPERATION (2)>
WHEN AREA CHANGES, RECEIVE NEW POSITION INFORMATION, AND BECAUSE THEY ARE DIFFERENT INFORMATION, START POSITION INFORMATION REGISTRATION WITH TERMINAL
<WLAN OPERATION>
AT THIS TIMING, CALL UP ASSOCIATED WLAN PROFILE FROM PUBLIC WIRELESS BASE STATION-WLAN PROFILE TABLE, AND TURN OFF WLAN WHEN SET PROFILE IS NOT PRESENT
MOVE
POSITION INFORMATION (EVERY 2.56 SECONDS)
STORE THEREIN CURRENT POSITION INFORMATION
PUBLIC WIRELESS BASE STATION A
<OPERATION (1)>
RECEIVE POSITION INFORMATION EVERY 2.56 SECONDS, COMPARE WITH POSITION INFORMATION STORED THEREIN, AND PERFORM NO PROCESSING IF IDENTICAL

FIG.7

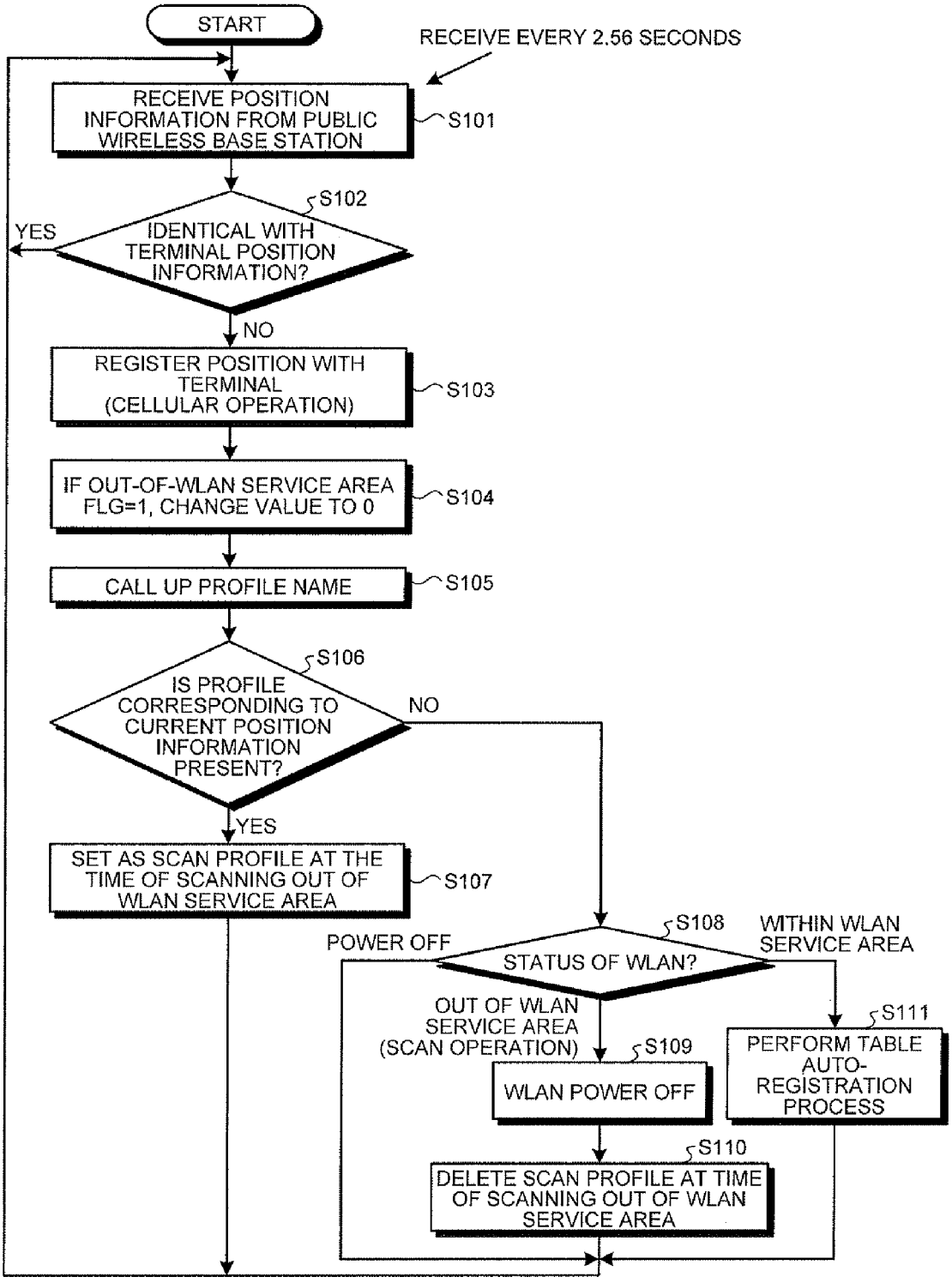

START
RECEIVE EVERY 2.56 SECONDS
RECEIVE POSITION INFORMATION FROM PUBLIC WIRELESS BASE STATION
S101
S102
IDENTICAL WITH TERMINAL POSITION INFORMATION?
YES
NO
REGISTER POSITION WITH TERMINAL (CELLULAR OPERATION)
S103
IF OUT-OF-WLAN SERVICE AREA FLG=1, CHANGE VALUE TO 0
S104
CALL UP PROFILE NAME
S105
S106
IS PROFILE CORRESPONDING TO CURRENT POSITION INFORMATION PRESENT?
NO
YES
SET AS SCAN PROFILE AT THE TIME OF SCANNING OUT OF WLAN SERVICE AREA
S107
S108
STATUS OF WLAN?
POWER OFF
WITHIN WLAN SERVICE AREA
OUT OF WLAN SERVICE AREA (SCAN OPERATION)
S109
WLAN POWER OFF
S110
DELETE SCAN PROFILE AT TIME OF SCANNING OUT OF WLAN SERVICE AREA
S111
PERFORM TABLE AUTO-REGISTRATION PROCESS

FIG.8

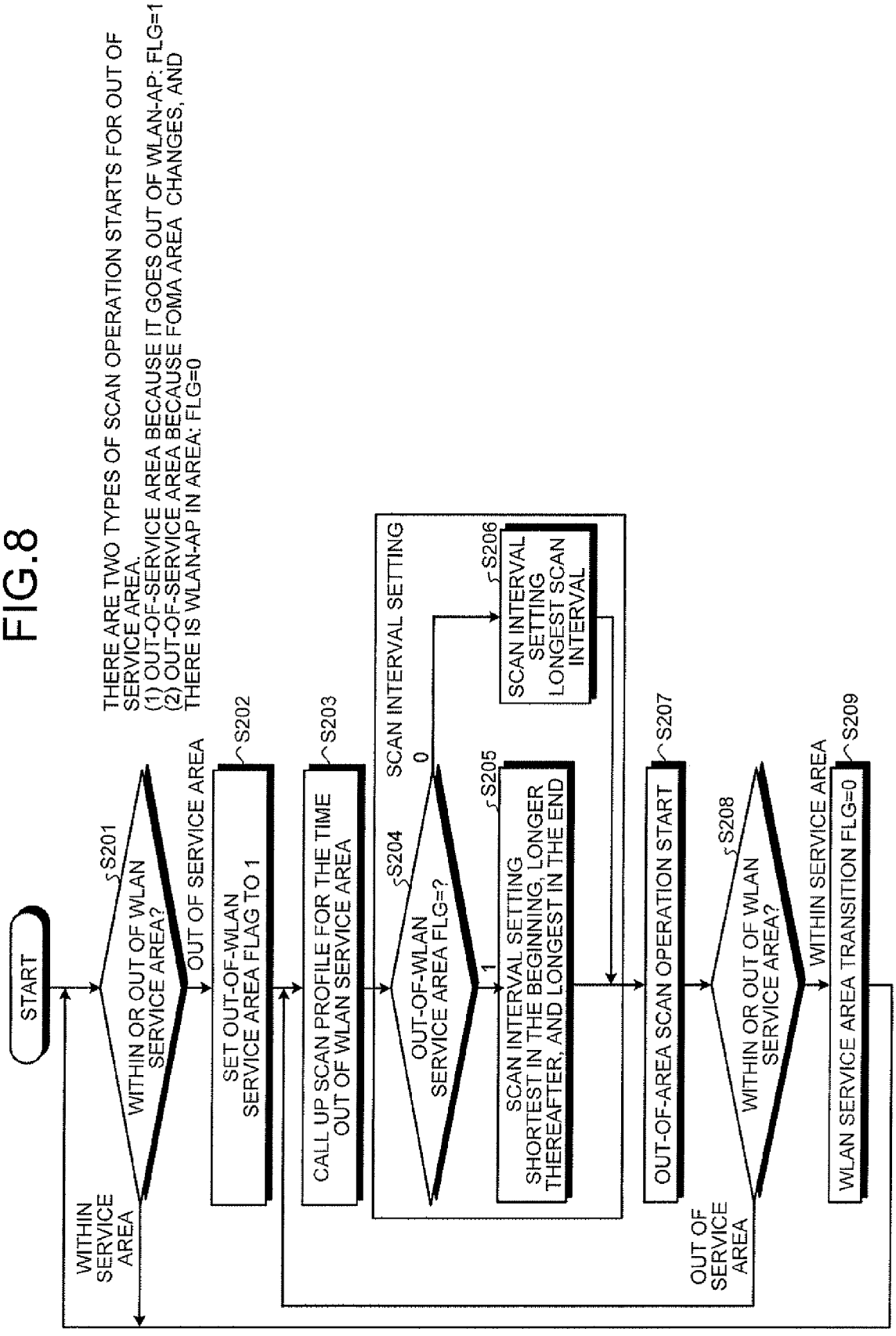

THERE ARE TWO TYPES OF SCAN OPERATION STARTS FOR OUT OF SERVICE AREA.
(1) OUT-OF-SERVICE AREA BECAUSE IT GOES OUT OF WLAN-AP: FLG=1
(2) OUT-OF-SERVICE AREA BECAUSE FOMA AREA CHANGES, AND THERE IS WLAN-AP IN AREA: FLG=0
START
S201
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
OUT OF SERVICE AREA
S202
SET OUT-OF-WLAN SERVICE AREA FLAG TO 1
S203
CALL UP SCAN PROFILE FOR THE TIME OUT OF WLAN SERVICE AREA
SCAN INTERVAL SETTING
S204
OUT-OF-WLAN SERVICE AREA FLG=?
0
1
S205
SCAN INTERVAL SETTING SHORTEST IN THE BEGINNING, LONGER THEREAFTER, AND LONGEST IN THE END
S206
SCAN INTERVAL SETTING LONGEST SCAN INTERVAL
S207
OUT-OF-AREA SCAN OPERATION START
S208
WITHIN OR OUT OF WLAN SERVICE AREA?
OUT OF SERVICE AREA
WITHIN SERVICE AREA
S209
WLAN SERVICE AREA TRANSITION FLG=0

FIG.9

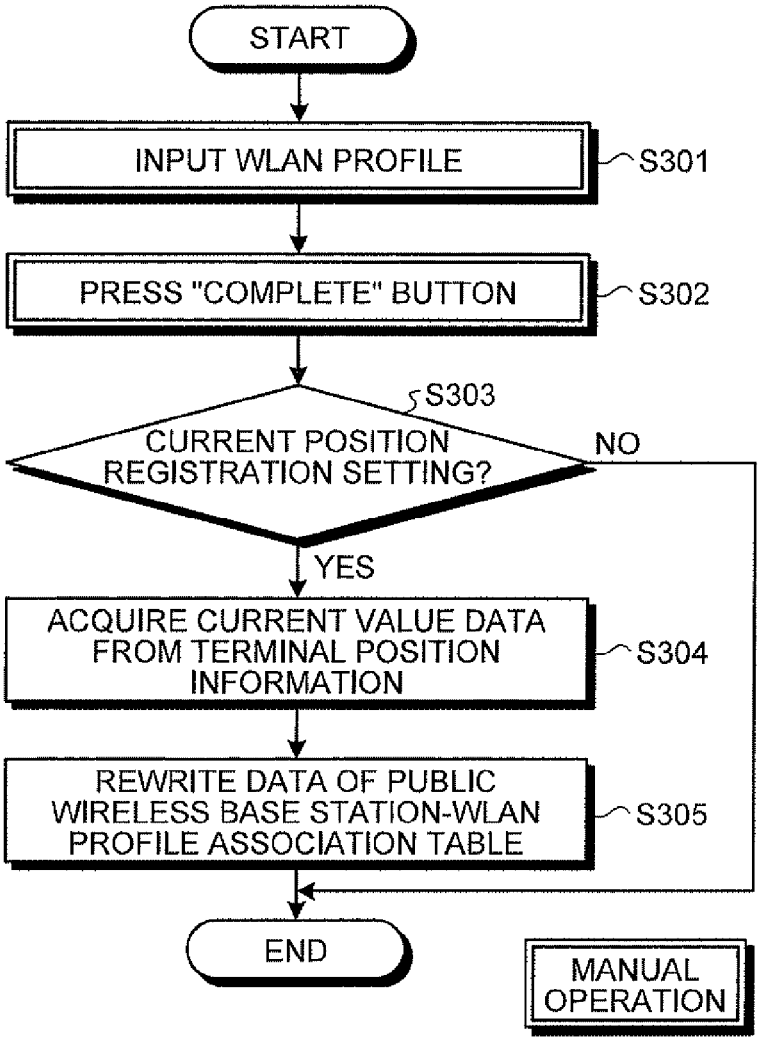


FIG.10

POSITION INFORMATION ACQUIRED FROM BASE STATION	PROFILE NAME	WIRELESS CHANNEL SETTING	NUMBER OF TIMES OF SCANNING
A	PROFILE 01	1,6	2
A	PROFILE 02	1,6,11,13	4
B	PROFILE 03	1	1
C	PROFILE 04	6,11	2
C	PROFILE 05	1,6,11	3

FIG.11

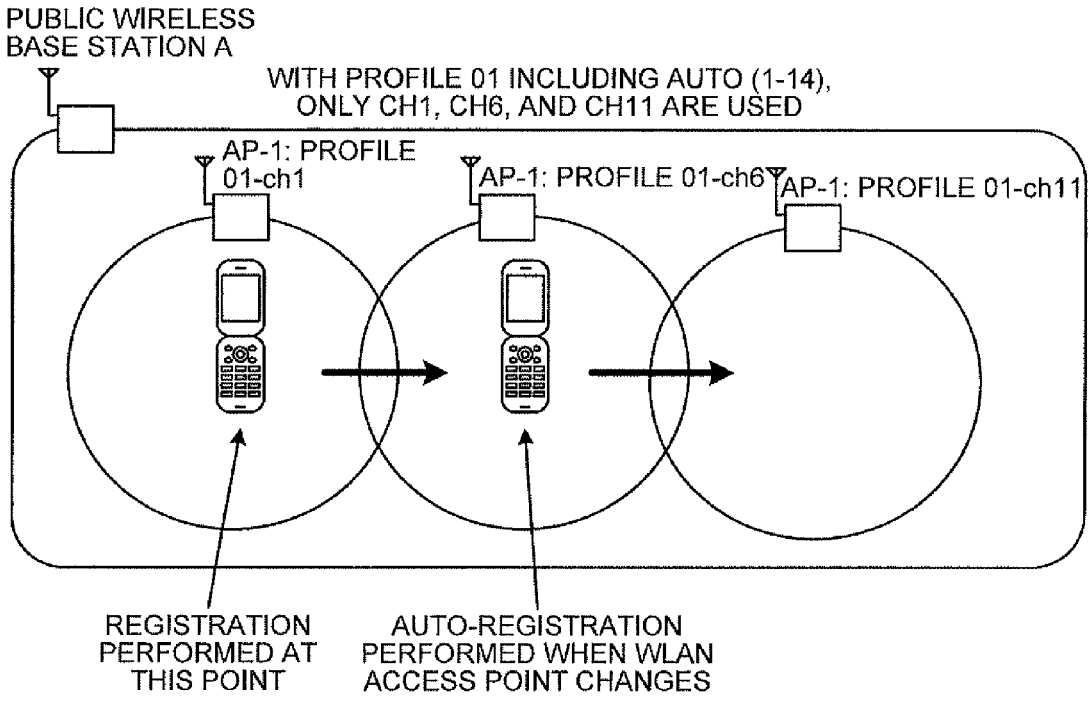

PUBLIC WIRELESS
BASE STATION A
WITH PROFILE 01 INCLUDING AUTO (1-14),
ONLY CH1, CH6, AND CH11 ARE USED
AP-1: PROFILE
01-ch1
AP-1: PROFILE 01-ch6
AP-1: PROFILE 01-ch11
REGISTRATION
PERFORMED AT
THIS POINT
AUTO-REGISTRATION
PERFORMED WHEN WLAN
ACCESS POINT CHANGES

FIG.12

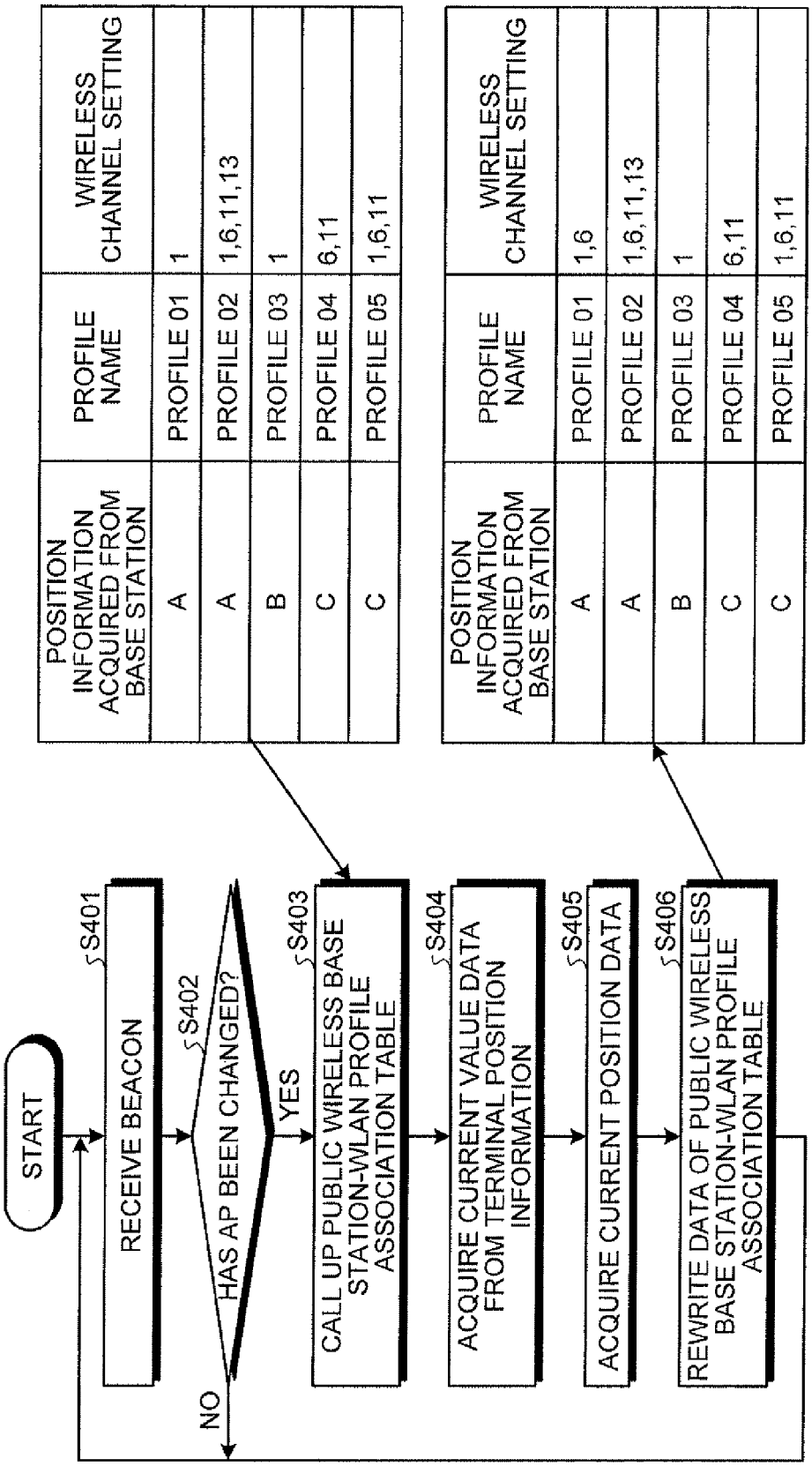

START
RECEIVE BEACON
S401
HAS AP BEEN CHANGED?
S402
YES
NO
CALL UP PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
S403
ACQUIRE CURRENT VALUE DATA FROM TERMINAL POSITION INFORMATION
S404
ACQUIRE CURRENT POSITION DATA
S405
REWRITE DATA OF PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
S406
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
WIRELESS CHANNEL SETTING
A
PROFILE 01
1
A
PROFILE 02
1,6,11,13
B
PROFILE 03
1
C
PROFILE 04
6,11
C
PROFILE 05
1,6,11
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
WIRELESS CHANNEL SETTING
A
PROFILE 01
1,6
A
PROFILE 02
1,6,11,13
B
PROFILE 03
1
C
PROFILE 04
6,11
C
PROFILE 05
1,6,11

FIG.13

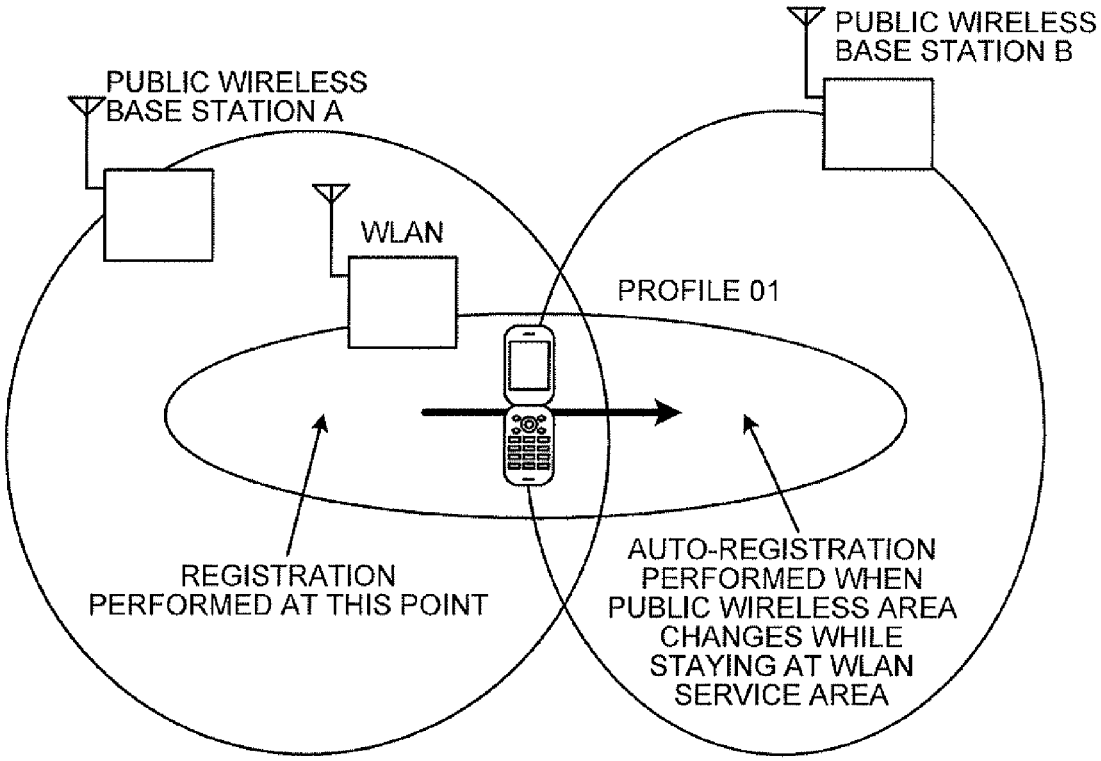

PUBLIC WIRELESS BASE STATION B
PUBLIC WIRELESS BASE STATION A
WLAN
PROFILE 01
REGISTRATION PERFORMED AT THIS POINT
AUTO-REGISTRATION PERFORMED WHEN PUBLIC WIRELESS AREA CHANGES WHILE STAYING AT WLAN SERVICE AREA

FIG.14

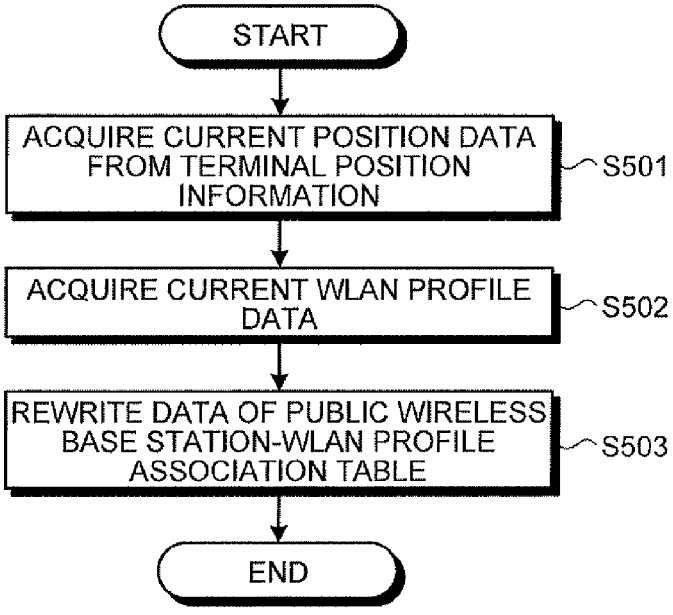

START
ACQUIRE CURRENT POSITION DATA FROM TERMINAL POSITION INFORMATION
S501
ACQUIRE CURRENT WLAN PROFILE DATA
S502
REWRITE DATA OF PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
S503
END

FIG.15

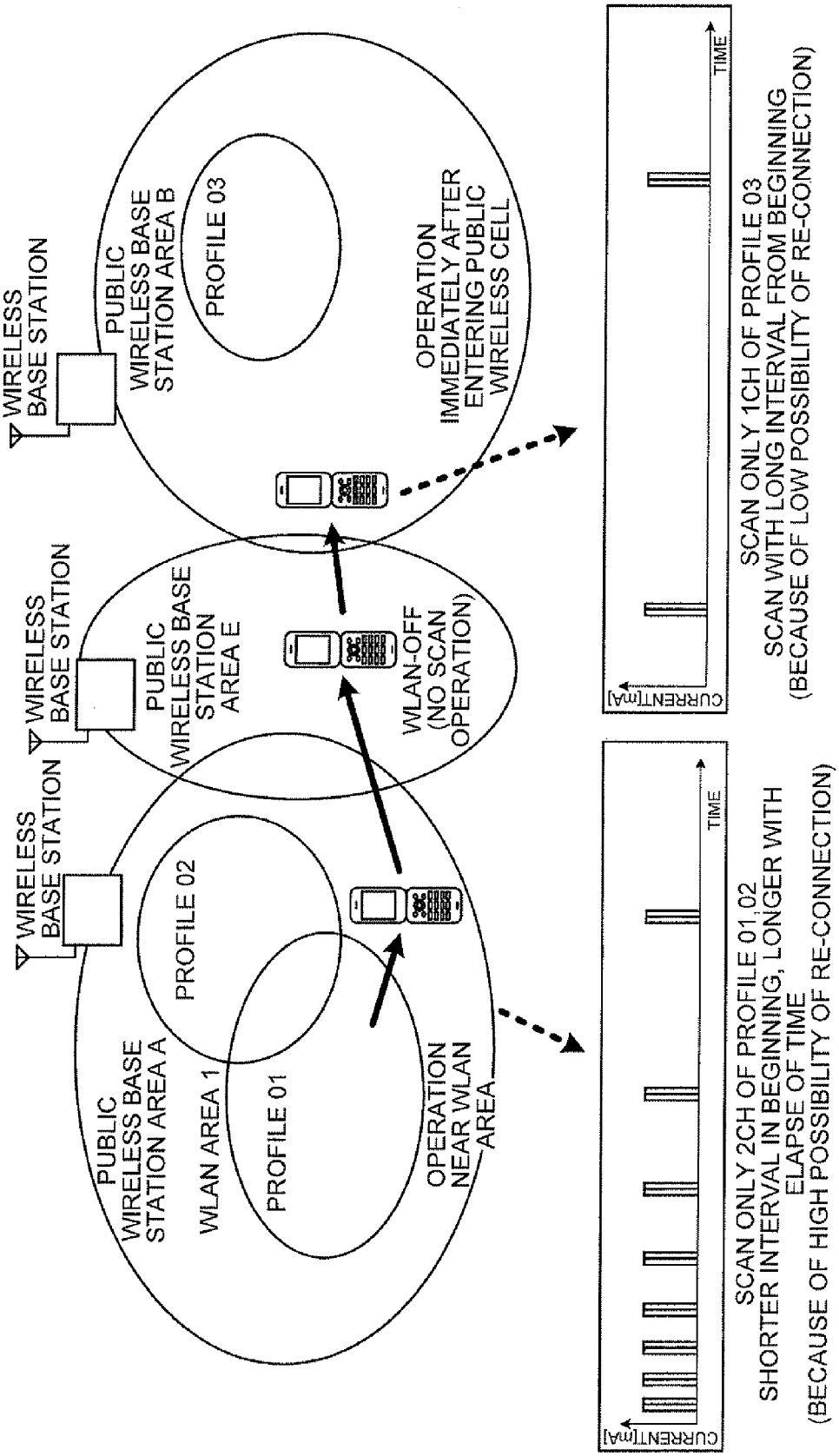

WIRELESS BASE STATION
PUBLIC WIRELESS BASE STATION AREA B
PROFILE 03
OPERATION IMMEDIATELY AFTER ENTERING PUBLIC WIRELESS CELL
WIRELESS BASE STATION
PUBLIC WIRELESS BASE STATION AREA E
WLAN-OFF (NO SCAN OPERATION)
WIRELESS BASE STATION
PUBLIC WIRELESS BASE STATION AREA A
WLAN AREA 1
PROFILE 02
PROFILE 01
OPERATION NEAR WLAN AREA
CURRENT[mA]
TIME
SCAN ONLY 1CH OF PROFILE 03
SCAN WITH LONG INTERVAL FROM BEGINNING
(BECAUSE OF LOW POSSIBILITY OF RE-CONNECTION)
CURRENT[mA]
TIME
SCAN ONLY 2CH OF PROFILE 01,02
SHORTER INTERVAL IN BEGINNING, LONGER WITH ELAPSE OF TIME
(BECAUSE OF HIGH POSSIBILITY OF RE-CONNECTION)

FIG.16

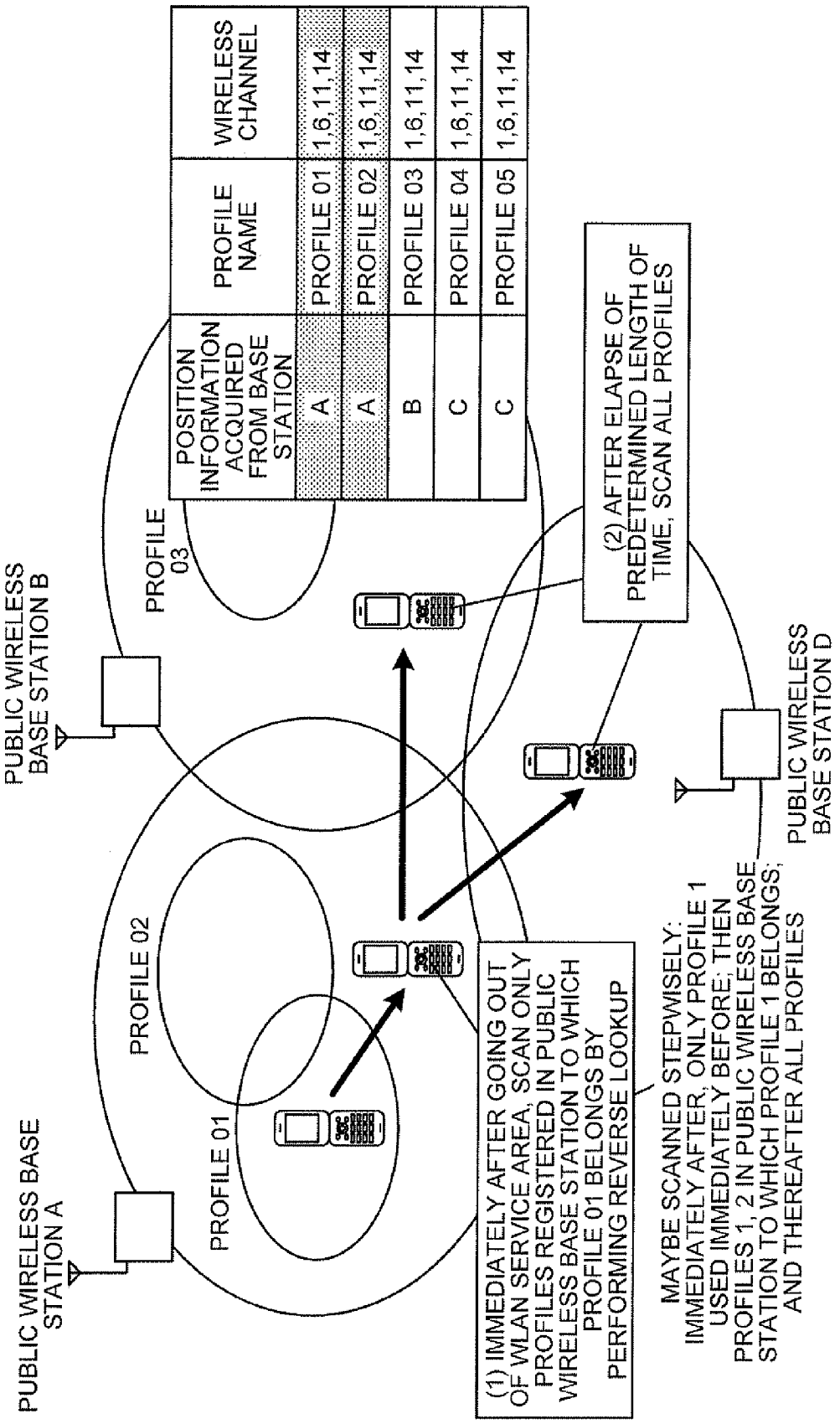

PUBLIC WIRELESS BASE STATION A
PUBLIC WIRELESS BASE STATION B
PUBLIC WIRELESS BASE STATION D
PROFILE 01
PROFILE 02
PROFILE 03
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
WIRELESS CHANNEL
A PROFILE 01 1,6,11,14
A PROFILE 02 1,6,11,14
B PROFILE 03 1,6,11,14
C PROFILE 04 1,6,11,14
C PROFILE 05 1,6,11,14
(1) IMMEDIATELY AFTER GOING OUT OF WLAN SERVICE AREA, SCAN ONLY PROFILES REGISTERED IN PUBLIC WIRELESS BASE STATION TO WHICH PROFILE 01 BELONGS BY PERFORMING REVERSE LOOKUP
(2) AFTER ELAPSE OF PREDETERMINED LENGTH OF TIME, SCAN ALL PROFILES
MAYBE SCANNED STEPWISELY: IMMEDIATELY AFTER, ONLY PROFILE 1 USED IMMEDIATELY BEFORE; THEN PROFILES 1, 2 IN PUBLIC WIRELESS BASE STATION TO WHICH PROFILE 1 BELONGS; AND THEREAFTER ALL PROFILES

FIG.17

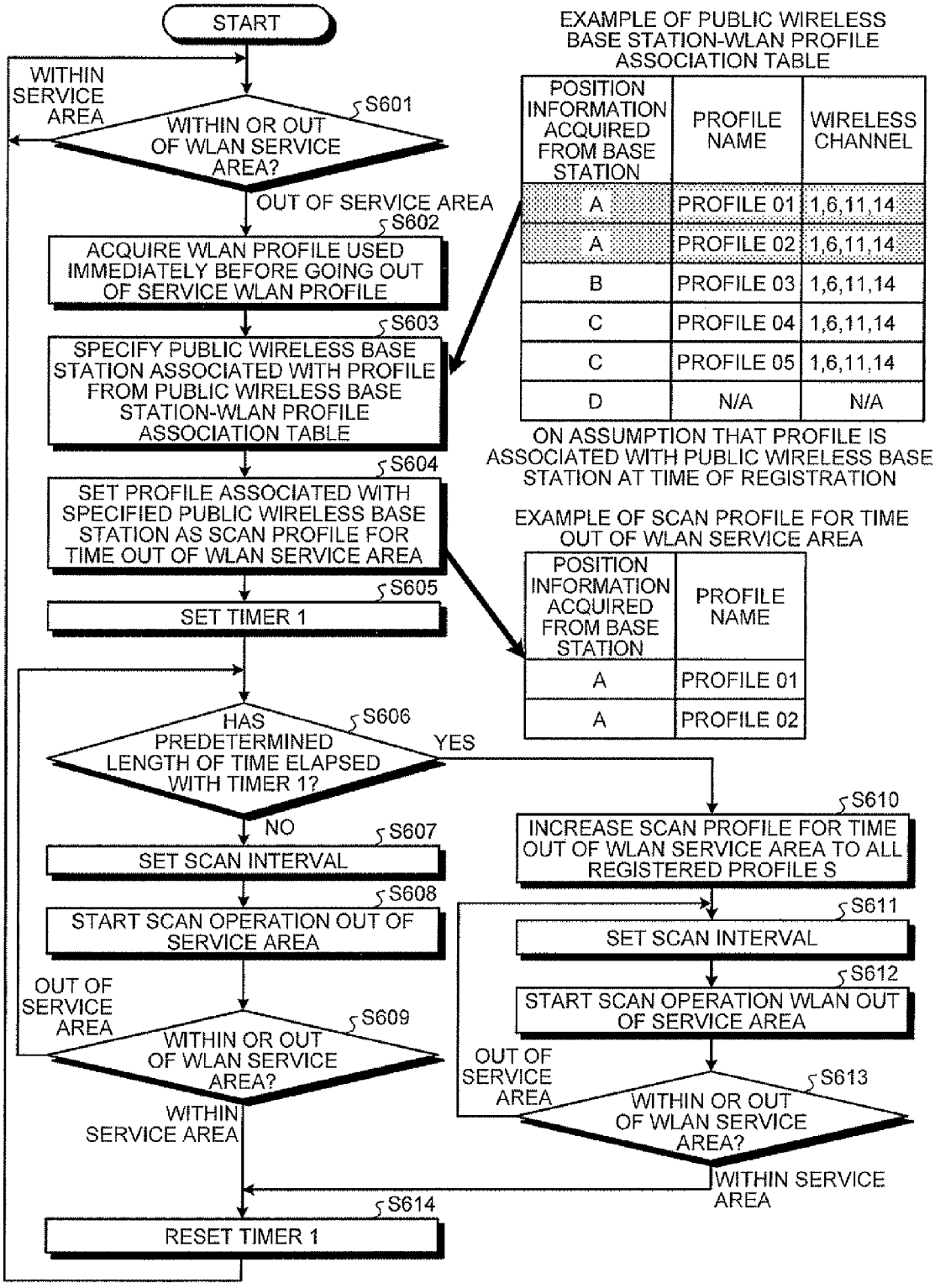

START
WITHIN SERVICE AREA
S601
WITHIN OR OUT OF WLAN SERVICE AREA?
OUT OF SERVICE AREA
S602
ACQUIRE WLAN PROFILE USED IMMEDIATELY BEFORE GOING OUT OF SERVICE WLAN PROFILE
S603
SPECIFY PUBLIC WIRELESS BASE STATION ASSOCIATED WITH PROFILE FROM PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
S604
SET PROFILE ASSOCIATED WITH SPECIFIED PUBLIC WIRELESS BASE STATION AS SCAN PROFILE FOR TIME OUT OF WLAN SERVICE AREA
S605
SET TIMER 1
S606
HAS PREDETERMINED LENGTH OF TIME ELAPSED WITH TIMER 1?
YES
NO
S607
SET SCAN INTERVAL
S608
START SCAN OPERATION OUT OF SERVICE AREA
OUT OF SERVICE AREA
S609
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
S614
RESET TIMER 1
S610
INCREASE SCAN PROFILE FOR TIME OUT OF WLAN SERVICE AREA TO ALL REGISTERED PROFILE S
S611
SET SCAN INTERVAL
S612
START SCAN OPERATION WLAN OUT OF SERVICE AREA
OUT OF SERVICE AREA
S613
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
EXAMPLE OF PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
WIRELESS CHANNEL
A PROFILE 01 1,6,11,14
A PROFILE 02 1,6,11,14
B PROFILE 03 1,6,11,14
C PROFILE 04 1,6,11,14
C PROFILE 05 1,6,11,14
D N/A N/A
ON ASSUMPTION THAT PROFILE IS ASSOCIATED WITH PUBLIC WIRELESS BASE STATION AT TIME OF REGISTRATION
EXAMPLE OF SCAN PROFILE FOR TIME OUT OF WLAN SERVICE AREA
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
A PROFILE 01
A PROFILE 02

FIG.18

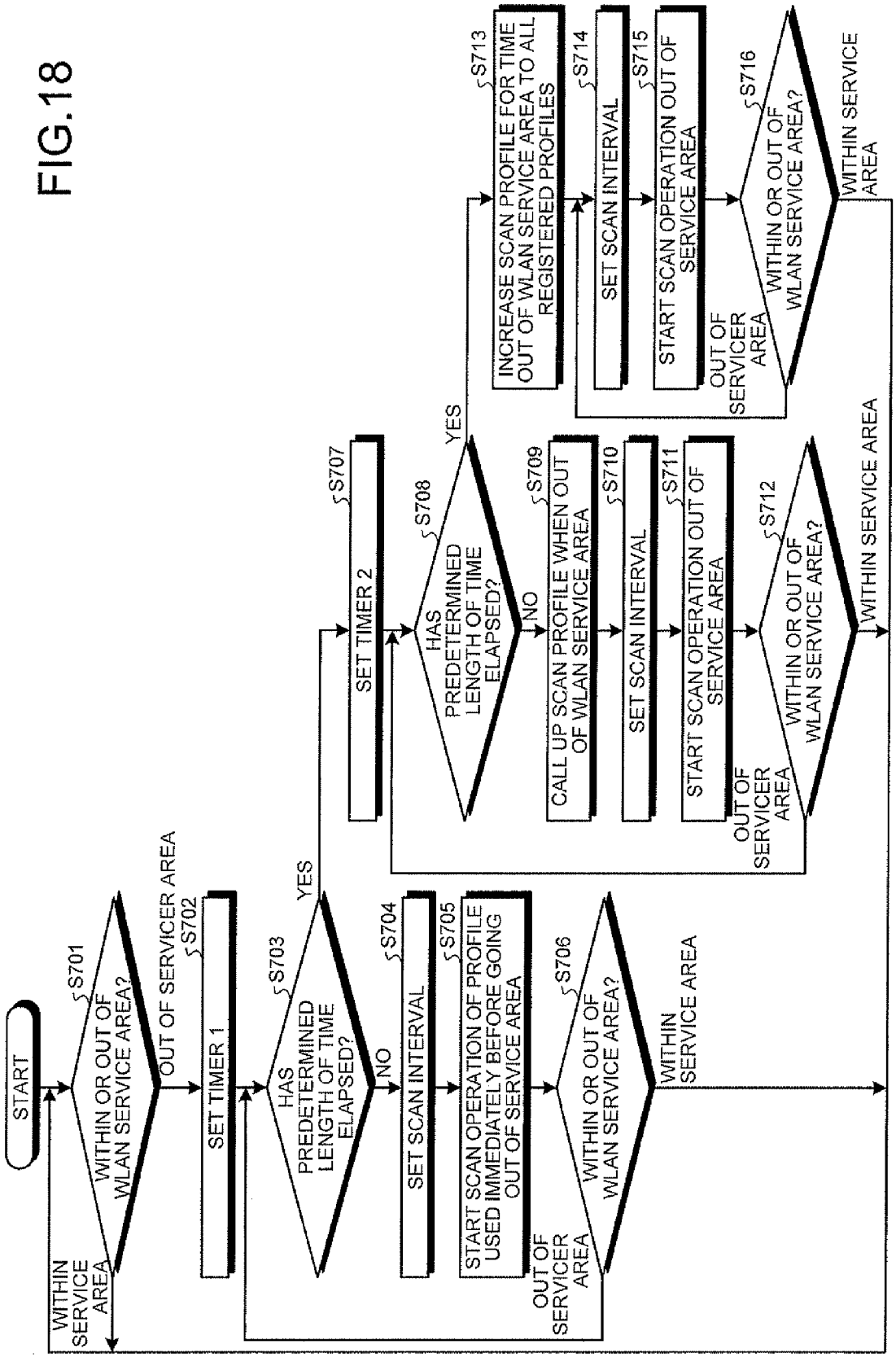

START
S701
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
OUT OF SERVICER AREA
S702
SET TIMER 1
S703
HAS PREDETERMINED LENGTH OF TIME ELAPSED?
YES
NO
S704
SET SCAN INTERVAL
S705
START SCAN OPERATION OF PROFILE USED IMMEDIATELY BEFORE GOING OUT OF SERVICE AREA
S706
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
OUT OF SERVICER AREA
S707
SET TIMER 2
S708
HAS PREDETERMINED LENGTH OF TIME ELAPSED?
YES
NO
S709
CALL UP SCAN PROFILE WHEN OUT OF WLAN SERVICE AREA
S710
SET SCAN INTERVAL
S711
START SCAN OPERATION OUT OF SERVICE AREA
S712
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
OUT OF SERVICER AREA
S713
INCREASE SCAN PROFILE FOR TIME OUT OF WLAN SERVICE AREA TO ALL REGISTERED PROFILES
S714
SET SCAN INTERVAL
S715
START SCAN OPERATION OUT OF SERVICE AREA
S716
WITHIN OR OUT OF WLAN SERVICE AREA?
WITHIN SERVICE AREA
OUT OF SERVICER AREA

FIG.19

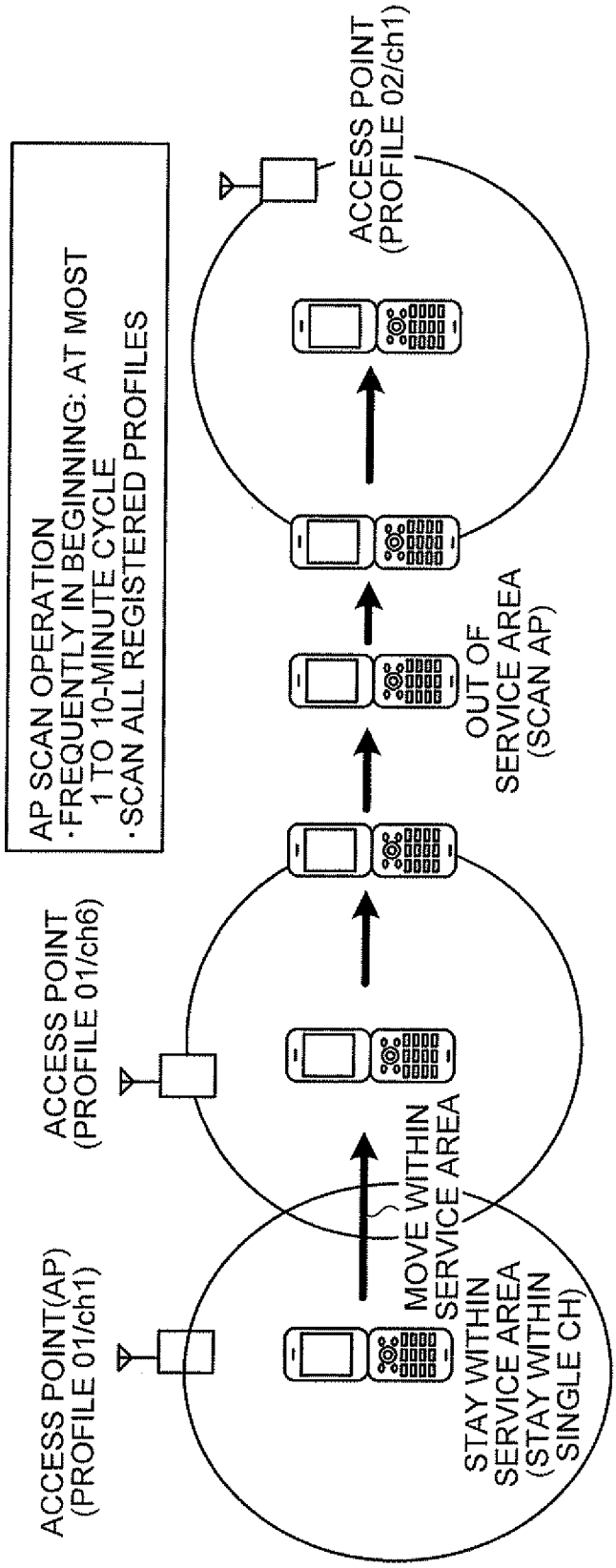

AP SCAN OPERATION
·FREQUENTLY IN BEGINNING: AT MOST 1 TO 10-MINUTE CYCLE
·SCAN ALL REGISTERED PROFILES
ACCESS POINT(AP) (PROFILE 01/ch1)
ACCESS POINT (PROFILE 01/ch6)
ACCESS POINT (PROFILE 02/ch1)
STAY WITHIN SERVICE AREA (STAY WITHIN SINGLE CH)
MOVE WITHIN SERVICE AREA
OUT OF SERVICE AREA (SCAN AP)

FIG.20

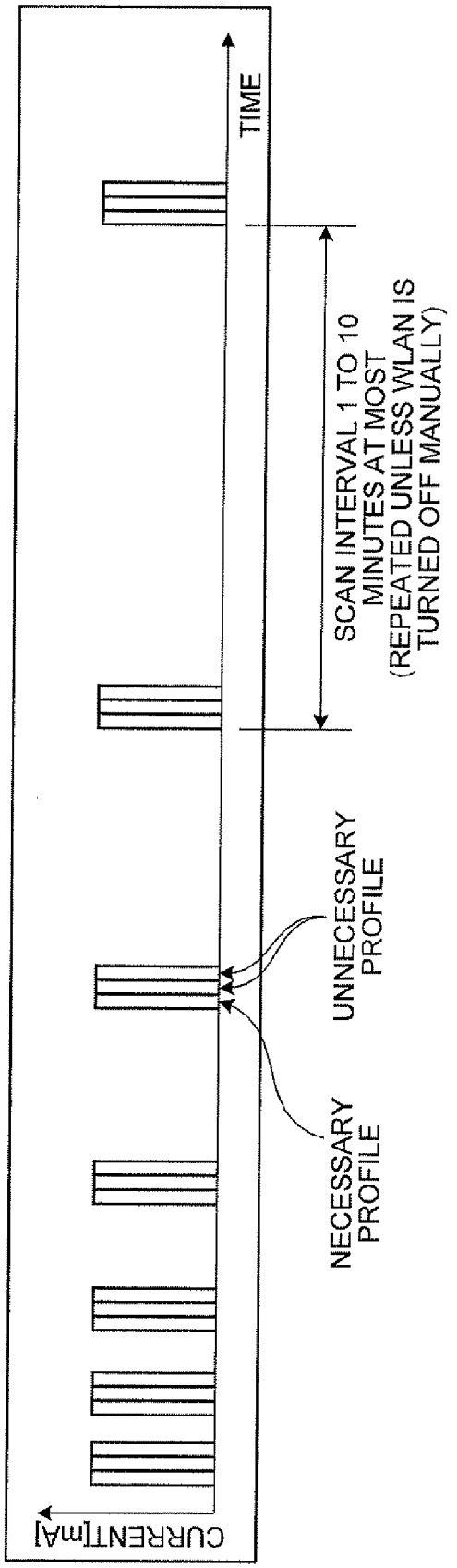

TIME
SCAN INTERVAL 1 TO 10 MINUTES AT MOST (REPEATED UNLESS WLAN IS TURNED OFF MANUALLY)
UNNECESSARY PROFILE
NECESSARY PROFILE
CURRENT[mA]

FIG.21

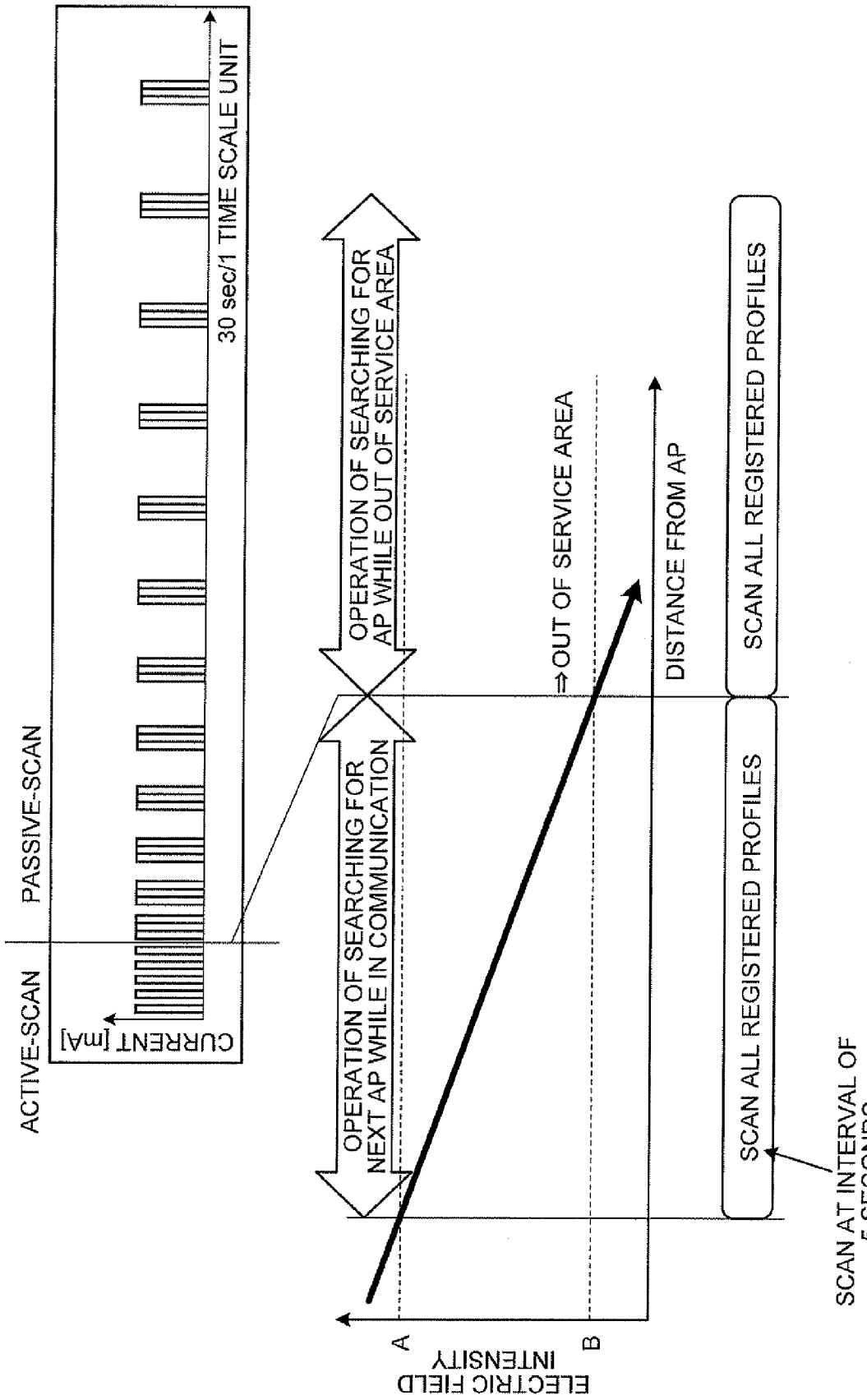

ACTIVE-SCAN
PASSIVE-SCAN
CURRENT [mA]
30 sec/1 TIME SCALE UNIT
OPERATION OF SEARCHING FOR NEXT AP WHILE IN COMMUNICATION
OPERATION OF SEARCHING FOR AP WHILE OUT OF SERVICE AREA
⇒OUT OF SERVICE AREA
DISTANCE FROM AP
SCAN ALL REGISTERED PROFILES
SCAN ALL REGISTERED PROFILES
SCAN AT INTERVAL OF 5 SECONDS
ELECTRIC FIELD INTENSITY
A
B

FIG.22

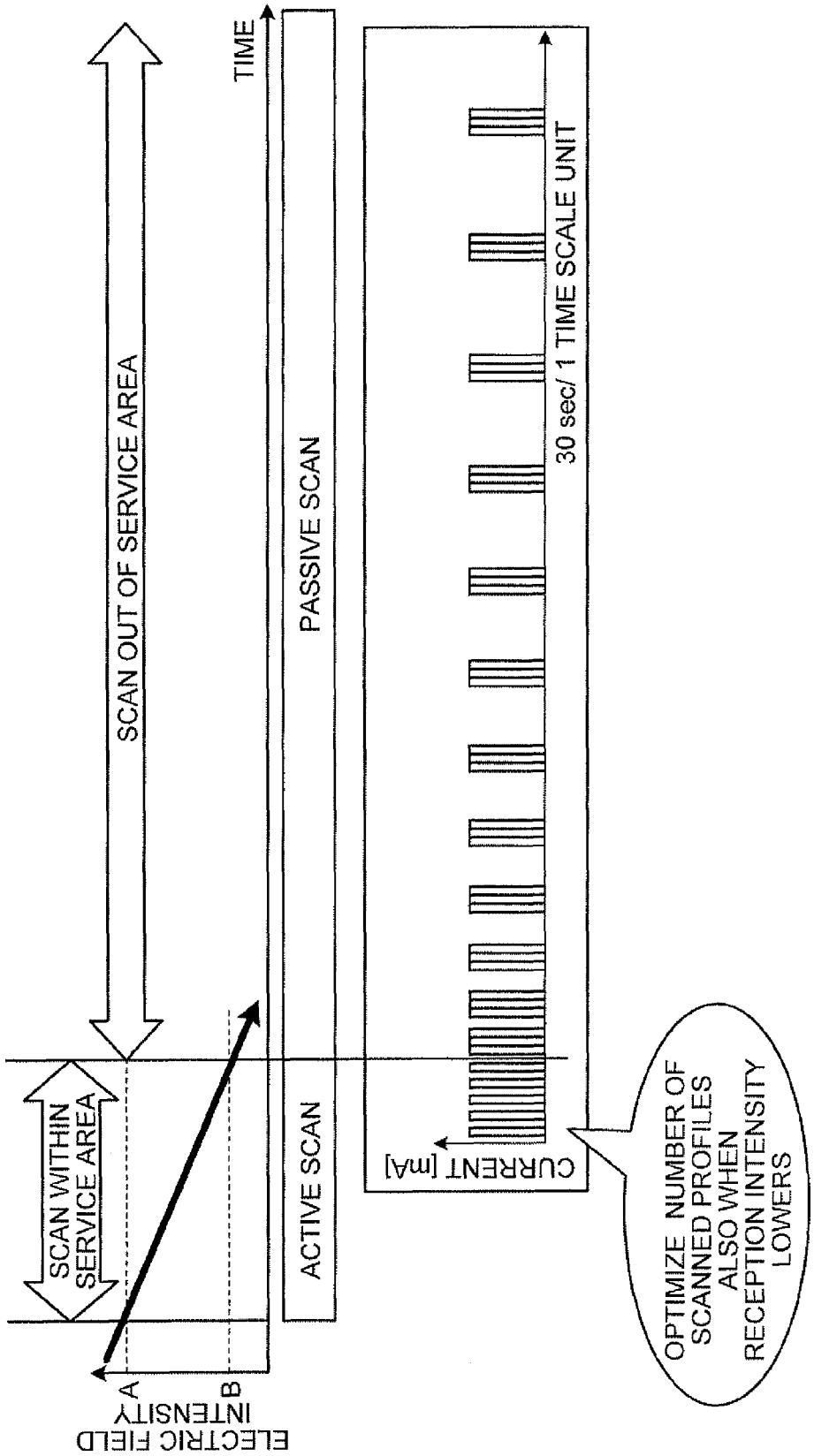
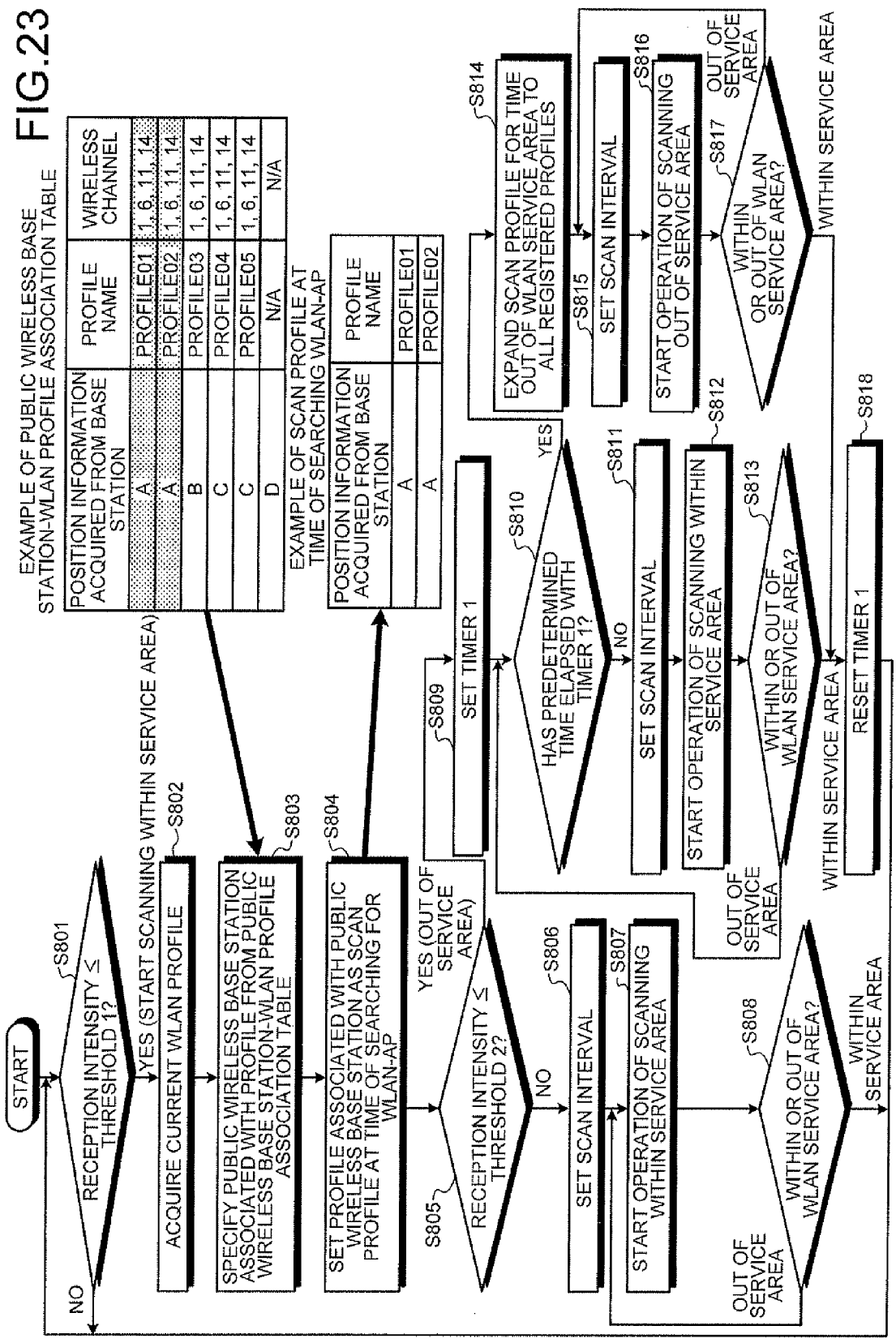

TIME
SCAN OUT OF SERVICE AREA
PASSIVE SCAN
ACTIVE SCAN
SCAN WITHIN SERVICE AREA
ELECTRIC FIELD INTENSITY
A
B
CURRENT [mA]
30 sec/ 1 TIME SCALE UNIT
OPTIMIZE NUMBER OF SCANNED PROFILES ALSO WHEN RECEPTION INTENSITY LOWERS

FIG.23


EXAMPLE OF PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
WIRELESS CHANNEL
A
PROFILE01
1, 6, 11, 14
A
PROFILE02
1, 6, 11, 14
B
PROFILE03
1, 6, 11, 14
C
PROFILE04
1, 6, 11, 14
C
PROFILE05
1, 6, 11, 14
D
N/A
N/A
EXAMPLE OF SCAN PROFILE AT TIME OF SEARCHING WLAN-AP
POSITION INFORMATION ACQUIRED FROM BASE STATION
PROFILE NAME
A
PROFILE01
A
PROFILE02
START
S801
RECEPTION INTENSITY ≤ THRESHOLD 1?
NO
YES (START SCANNING WITHIN SERVICE AREA)
S802
ACQUIRE CURRENT WLAN PROFILE
S803
SPECIFY PUBLIC WIRELESS BASE STATION ASSOCIATED WITH PROFILE FROM PUBLIC WIRELESS BASE STATION-WLAN PROFILE ASSOCIATION TABLE
S804
SET PROFILE ASSOCIATED WITH PUBLIC WIRELESS BASE STATION AS SCAN PROFILE AT TIME OF SEARCHING FOR WLAN-AP
S805
RECEPTION INTENSITY ≤ THRESHOLD 2?
YES (OUT OF SERVICE AREA)
NO
S806
SET SCAN INTERVAL
S807
START OPERATION OF SCANNING WITHIN SERVICE AREA
S808
WITHIN OR OUT OF WLAN SERVICE AREA?
OUT OF SERVICE AREA
WITHIN SERVICE AREA
S809
SET TIMER 1
S810
HAS PREDETERMINED TIME ELAPSED WITH TIMER 1?
YES
NO
S811
SET SCAN INTERVAL
S812
START OPERATION OF SCANNING WITHIN SERVICE AREA
S813
WITHIN OR OUT OF WLAN SERVICE AREA?
OUT OF SERVICE AREA
WITHIN SERVICE AREA
S814
EXPAND SCAN PROFILE FOR TIME OUT OF WLAN SERVICE AREA TO ALL REGISTERED PROFILES
S815
SET SCAN INTERVAL
S816
START OPERATION OF SCANNING OUT OF SERVICE AREA
S817
WITHIN OR OUT OF WLAN SERVICE AREA?
OUT OF SERVICE AREA
WITHIN SERVICE AREA
S818
RESET TIMER 1

WIRELESS COMMUNICATION TERMINAL AND WIRELESS COMMUNICATION TERMINAL CONTROL METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of and claims the benefit of priority of U.S. patent application Ser. No. 12/359,315, with a filing date of Jan. 24, 2009, the entire contents of which are incorporated herein by reference. This application also is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2009-013553, filed on Jan. 23, 2009, the entire contents of which also are incorporated herein by reference.

FIELD

The embodiment discussed herein is directed to a wireless communication terminal that performs first wireless communication via a base station in a wireless public network, and performs second wireless communication via a wireless local area network (LAN) access point in a wireless LAN communication network smaller than the wireless public network, and a control method thereof.

BACKGROUND

A mobile phone (for example, a fixed mobile convergence (FMC) terminal, and a dual terminal) having a public network having a wide area (for example, freedom of mobile multimedia access (FOMA)), and a wireless communication network having a small area such as wireless local area network (WLAN) has been known. Such a mobile phone makes a call by data communication and voice over internet protocol (VoIP) in a communication area of WLAN-Access Point (AP), and performs operation of receiving Beacon in the absence of a call by the data communication and the VoIP. In the area outside WLAN-AP, the operation of receiving Beacon is stopped, and operation of scanning outside the WLAN area is performed regularly (see FIG. **19**). A scan interval of the scan operation is set shorter so that connection can be established soon after entering the WLAN-AP.

When a mobile terminal is out of the WLAN-AP, a power source for WLAN can be turned off manually, but if a user forgets to turn off the power source, the scan operation is performed, and unnecessary electricity is consumed (see FIG. **20**). For example, the user goes to a business trip without turning off the power source for WLAN, electricity is consumed by unintended scan operation, and the mobile terminal cannot be used as a telephone.

Technologies for solving unnecessary scan operation include a method disclosed in Japanese Laid-open Patent Publication No. 2007-116294 in which a contactless integrated circuit (IC) card is attached to a terminal, an entrance/exit managing apparatus (card reader) is prepared, IC card information is rewritten at the time of exit, and thereby a power source for WLAN is turned off. Moreover, Japanese Laid-open Patent Publication No. 2006-295643 discloses a method of turning on/off the power source for WLAN by a mobile phone base station notifying the terminal of a wireless LAN base station information in the base station.

As a technology for solving unnecessary scan operation, Japanese Laid-open Patent Publication No. 2006-13594 discloses a method of increasing the scan interval gradually, reducing the number of times of the scan operation, and suppressing consumed electricity. Japanese Laid-open Patent Publication No. 2005-229399 discloses a method of turning on/off the power source for WLAN by acquiring position information using global positioning system (GPS), and specifying WLAN areas.

With the technology disclosed in Japanese Laid-open Patent Publication No. 2007-116294, many additional facilities are required and the cost increases because an entrance/exit managing apparatus needs to be provided. Besides, with the technology disclosed in Japanese Laid-open Patent Publication No. 2006-295643, it is not suited for the access point for use by a corporation (company) and an individual and a complicate system architecture including a carrier is necessary because a mobile phone base station notifies a terminal of wireless LAN base station information in the base station.

With the technology disclosed in Japanese Laid-open Patent Publication No. 2006-13594, response at the time of restoration deteriorates because a scan interval is increased gradually. With the technology disclosed in Japanese Laid-open Patent Publication No. 2005-229399, electricity is consumed for position detection by GPS because position information is acquired by using GPS.

SUMMARY

According to an aspect of an embodiment, a wireless communication terminal performs first wireless communication via a base station in a public network, and second wireless communication via a wireless LAN access point in a wireless LAN communication network smaller than the wireless public network. The wireless communication terminal includes a base station profile storing unit, a current position information receiving and storing unit, a wireless profile setting unit, and a wireless profile scan unit. The base station profile storing unit stores position information transmitted from the base station in association with a wireless LAN profile that is wireless LAN access point information in a communication area of the base station. The current position information receiving and storing unit receives current position information of the wireless communication terminal from the base station and stores the current position information. The wireless profile setting unit reads a wireless LAN profile corresponding to the current position information received by the current position information receiving and storing unit from the base station profile storing unit, and sets the wireless LAN profile. The wireless profile scan unit scans the wireless LAN profile set by the wireless profile setting unit when reception intensity from the wireless LAN access point decreases below a predetermined threshold.

The object and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF DRAWING(S)

FIG. **1** is a diagram for explaining an outline and features of a mobile phone terminal according to a first embodiment of the invention;

FIG. **2** is a block diagram of the mobile phone terminal according to the first embodiment illustrated in FIG. **1**;

FIG. **3** is an example of a public wireless base station-WLAN profile association table;

FIG. **4** is an example of a scan profile storing unit when out of the WLAN service area;

FIG. **5** is a diagram for explaining registration process by operation;

FIG. **6** is a diagram for explaining position information registration process;

FIG. **7** is a flowchart of scan profile setting process performed by the mobile phone terminal of the first embodiment illustrated in FIG. **1**;

FIG. **8** is a flowchart of scan interval setting process performed by the mobile phone terminal of the first embodiment illustrated in FIG. **1**;

FIG. **9** is a flowchart of profile registration process performed by the mobile phone terminal of the first embodiment illustrated in FIG. **1**;

FIG. **10** is an example of a public wireless base station-WLAN profile association table **14***b* stored in a mobile phone terminal according to a second embodiment of the invention;

FIG. **11** is a diagram for explaining the process of registration for each wireless channel,

FIG. **12** is a flowchart of the process of registration for each wireless channel of the mobile phone terminal of the second embodiment;

FIG. **13** is a diagram for explaining the process of table auto-registration;

FIG. **14** is a flowchart of the process of the table auto-registration;

FIG. **15** is a diagram for explaining scan interval setting process

FIG. **16** is a diagram for explaining scan process after a mobile phone terminal according to a third embodiment of the invention goes out of the WLAN service area;

FIG. **17** is a flowchart of scan process after the mobile phone terminal of the third embodiment goes out of the WLAN service area;

FIG. **18** is a flowchart of another scan process after the mobile phone terminal of the third embodiment goes out of the WLAN service area;

FIG. **19** is a diagram for explaining a conventional technology; and

FIG. **20** is a diagram for explaining a conventional technology.

FIG. **21** is a diagram for explaining a conventional operation when reception intensity lowers;

FIG. **22** is a diagram for explaining an outline of a mobile phone terminal according to a fourth embodiment of the invention; and

FIG. **23** is a flowchart of scan process when reception intensity of a mobile phone terminal of the fourth embodiment becomes equal to or lower than a threshold.

DESCRIPTION OF EMBODIMENT(S)

Exemplary embodiments of the invention are described below with reference to the accompanying drawings.

In the following, an outline and features of a mobile phone terminal according to a first embodiment of the invention, and a configuration and a processing flow of the mobile phone terminal are described. In the following example, a fixed mobile convergence (FMC) terminal and a dual terminal are exemplified as mobile phone terminals having both a wide-area public network (FOMA, for example), and a small-area wireless communication network such as WLAN.

An outline and features of a mobile phone terminal of the first embodiment is described with reference to FIG. **1**. FIG. **1** is a diagram for explaining the outline and the features of the mobile phone terminal according to the first embodiment.

A mobile phone terminal **10** according to the first embodiment can perform both a wireless communication via a FOMA wireless base station **20** (hereinafter, a public wireless base station) in a wireless public network, and a wireless communication via a WLAN access point in a WLAN communication network having a smaller area than that of the wireless public network. The mobile phone terminal **10** can be realized with less cost and with a simple configuration, and provides a significant power saving effect.

Explaining specifically about its main features, as illustrated in FIG. **1**, the mobile phone terminal **10** has a public wireless base station-WLAN profile association table **14***b* that stores position information acquired from a base station, names of wireless LAN profiles that are wireless LAN access point information in a communication area of the public wireless base station, and wireless channels in the profiles, in association with each other.

In this configuration, the mobile phone terminal **10** receives and stores therein its current position information from a public wireless base station **20** (see (**1**) in FIG. **1**). Specifically, the mobile phone terminal **10** receives the position information every 2.56 seconds by a cellular system, and when the information is different from that stored in the mobile phone terminal **10** starts position information registration with the terminal (see FIG. **6** described below).

The mobile phone terminal **10** reads out a profile name corresponding to the acquired current position information from the public wireless base station-WLAN profile association table **14***b*, and sets the read WLAN profile as a scan profile (see (**2**) in FIG. **1**).

The mobile phone terminal **10** then scans the set WLAN profile when located outside the WLAN service area, i.e., when located outside the communication area of the wireless LAN access point (see (**3**) in FIG. **1**). In other words, explaining with reference to the example illustrated in FIG. **1**, the mobile phone terminal **10** scans "Profile**1**" and "Profile**2**" in a public wireless base station "A", and the mobile phone terminal **10** scans only "Profile**3**" in a public wireless base station "B".

The mobile phone terminal **10** turns off power source for WLAN when located outside the WLAN service area, and the WLAN profile is not set in the public wireless base station-WLAN profile association table **14***b*, that is when the WLAN profile is not present in the public wireless base station **20** (see (**4**) in FIG. **1**).

As described above, the mobile phone terminal **10** turns on/off the power source for WLAN depending on a public wireless base station area, unnecessary electricity for cellular search when the mobile phone terminal **10** is out of the service area can be reduced, only necessary WLAN profiles are scanned at a location where they are necessary, and connection becomes available as soon as the mobile phone terminal **10** enters an access point. Accordingly, a mobile phone terminal that can be realized with less cost and a simple configuration, and provides a significant power saving effect can be provided as in its main features described above.

The configuration of the mobile phone terminal **10** illustrated in FIG. **1** is described with reference to FIG. **2**. FIG. **2** is a block diagram of the mobile phone terminal **10** according to the first embodiment. As illustrated in FIG. **2**, the mobile phone terminal **10** has a first RF transceiver **11**, a second RF transceiver **12**, a controller **13**, and a storing unit **14**. The operation of these units is described below.

The first RF transceiver **11** transmits and receives information wirelessly via the FOMA wireless base station **20** in the wireless public network. The second RF transceiver **12** transmits and receives information wirelessly via the WLAN access point in the WLAN communication network.

The storing unit **14** stores therein data and programs necessary for various types of processing by the controller **13**, and specifically includes a terminal position storing unit **14***a*, the public wireless base station-WLAN profile association table **14***b*, and a scan profile storing unit **14***c* for the time out of the WLAN service area. The terminal position storing unit **14***a* stores terminal position information acquired by a terminal position acquiring unit **13***a* explained below.

The public wireless base station-WLAN profile association table **14***b* stores as illustrated in FIG. **3** position information acquired from the public wireless base station, names of wireless LAN profiles that are wireless LAN access point information in a communication area of the public wireless base station, and wireless channels in the profiles, in association with each other.

The scan profile storing unit **14***c* for the time out of the WLAN service area stores scan profiles at the time of scanning out of the WLAN service area set by a wireless profile registering unit **13***d* explained below. Specifically, the scan profile storing unit **14***c* for the time out of the WLAN area stores position information acquired from base stations and profile names in association with each other, as exemplified in FIG. **4**. The stored profiles are scanned at the time of out of the WLAN service area.

The controller **13** has an internal memory for storing therein a computer program specifying various processing procedures and required data, and performs various types of processing using the same. The controller **13** includes the terminal position acquiring unit **13***a*, a terminal position manager **13***b*, a wireless transceiver operation controller **13***c*, the wireless profile registering unit **13***d* and a power controller **13***e*.

The terminal position acquiring unit **13***a* receives and stores therein its current position information from the public wireless base station **20**. Specifically, the mobile phone terminal **10** receives position information every 2.56 seconds by a cellular system, and notifies the position information to the terminal position manager **13***b*.

The terminal position manager **13***b* manages the received position information. Specifically, the terminal position manager **13***b* compares as illustrated in FIG. **6** the position information notified from the terminal position acquiring unit **13***a* and position information stored in the terminal position storing unit **14***a*, and performs no processing if they are identical with each other. When they are not identical, the terminal position manager **13***b* starts position information registration process (cellular operation) with the terminal.

The terminal position manager **13***b* searches the public wireless base station-WLAN profile association table **14***b* based on the position information, and reads out a profile name corresponding to the acquired position information. When a profile corresponding to the public wireless base station is present, the terminal position manager **13***b* sets the read profile name in the scan profile storing unit **14***c* for the time out of the WLAN service area, as a scan profile at the time of scanning out of the service area.

The wireless transceiver operation controller **13***c* scans the WLAN profile set by the terminal position manager **13***b* at the time of out of the WLAN service area. Specifically, the wireless transceiver operation controller **13***c* reads out the scan profile storing unit **14***c* for the time out of the WLAN service area when scanning out of the service area when out of the WLAN service area, and when the WLAN profile is stored scans the read WLAN profile. When the WLAN profile is not set, the wireless transceiver operation controller **13***c* notifies the power controller **13***e* of this fact. When scanning the WLAN profile, scan intervals are set. This setting processing is explained in detail below with reference to FIG. **8**.

The wireless profile registering unit **13***d* registers position information, and profiles in association with each other in the public wireless base station-WLAN profile association table **14***b*. Specifically, when a WLAN profile is input by a manual operation with input keys, a complete button is pressed, and registration in association with the current public wireless base station is selected as illustrated in FIG. **5**, the wireless profile registering unit **13***d* acquires current value data from the terminal position information, and rewrites data in the public wireless base station-WLAN profile association table **14***b*.

The power controller **13***e* controls to turn off a power source for WLAN when a profile corresponding to the public wireless base station is not present at the time of out of the WLAN service area. Specifically, the power controller **13***e* turns off the power source for WLAN when notified by the wireless transceiver operation controller **13***c* that a WLAN profile is not set.

The operation of the mobile phone terminal **10** of the first embodiment is described with reference to FIGS. **7** to **9**. FIG. **7** is a flowchart of a scan profile setting process performed by the mobile phone terminal **10** according to the first embodiment, FIG. **8** is a flowchart of a scan interval setting process performed by the mobile phone terminal **10** according to the first embodiment, and FIG. **9** is a flowchart of a profile registration process performed by the mobile phone terminal **10** according to the first embodiment.

As illustrated in FIG. **7**, when the mobile phone terminal **10** receives position information from the public wireless base station (step **S101**), the mobile phone terminal **10** determines whether the position information is identical with the terminal position information stored therein (step **S102**), and when identical returns to the step **S101** without performing any processing. On the other hand, when the received position information and the stored position information are different, the mobile phone terminal **10** performs position registration process with the terminal (cellular operation) (step **S103**).

Then, when an out-of-WLAN service area flag indicates "1", the mobile phone terminal **10** changes the flag to indicate "0" (step **S104**), searches the public wireless base station-WLAN profile association table **14***b*, and calls up a profile name corresponding to the current position information (step **S105**).

When the profile corresponding to the current position information is present as a result (YES at the step **106**), the mobile phone terminal **10** sets the read profile name at the scan profile storing unit **14***c* for the time out of the WLAN service area as a scan profile for the time out of the service area (step **S107**).

On the other hand, when a profile corresponding to the public wireless base station is not present (NO at the step **106**), the mobile phone terminal **10** determines the status of WLAN (step **S108**). The mobile phone terminal **10** turns off power source for WLAN when located outside the WLAN service area (step **S109**), deletes a scan profile for the time scanning out of the WLAN service area (step **S110**), and reduces wasteful power consumption.

Moreover, when the status of the WLAN is within the WLAN service area, the mobile phone terminal **10** performs table auto-registration process (step **S111**). Explaining the table auto-registration process with reference to FIG. **14**, the mobile phone terminal **10** acquires current position data from the terminal position information (step **S501**), and acquires current WLAN profile data (step **S502**)

The mobile phone terminal **10** then rewrites data of the public wireless base station-WLAN profile association table **14***b* (step S**503**). Specifically, as illustrated in FIG. **13**, the mobile phone terminal **10** controls to perform auto-registration when the area of the public wireless base station changes while staying in the WLAN service area.

Scan interval setting process is described below with reference to FIG. **8**. As illustrated in FIG. **8**, the mobile phone terminal **10** determines whether the status of WLAN is within or out of the WLAN service area (Step S**201**). When the status is determined to be out of the service area, the out-of-WLAN service area flag is set as "1" (Step S**202**), and a scan program for out of the WLAN service area is called up (Step S**203**), and the scan interval setting process is performed.

The mobile phone terminal **10** determines whether the out-of-WLAN service area flag is "0" or "1" as the scan interval setting process (Step S**204**). When the out-of-WLAN service area flag is "1", the scan interval is set to be the shortest in the beginning, longer thereafter, and the longest in the end (Step S**205**). The mobile phone terminal **10** sets the scan interval to be the longest when the out-of-WLAN service area flag is changed to "0" in the process illustrated in FIG. **7** (Step S**206**).

The mobile phone terminal **10** then starts out-of-service area scan operation (Step S**207**), and determines whether it is within or outside the WLAN service area (Step S**208**). As a result, when determining that the mobile phone terminal **10** is outside the service area, the process returns to Step S**203**, and the process of Steps S**203** to S**207** are repeated. When the mobile phone terminal **10** determines it is within the WLAN service area, the out-of-WLAN service area flag is set as "0" (Step S**209**), and the process returns to Step S**201**.

Manual profile registration process is described below with reference to FIG. **9**. As illustrated in FIG. **9**, when a WLAN profile is input by a manual operation with input keys (step S**301**), a complete button is pressed (step S**302**), and registration in association with the current public wireless base station is selected (YES at step S**303**), the mobile phone terminal **10** acquires current value data from terminal position information (for example, public wireless base station ID) (step S**304**), and rewrites data of the public wireless base station-WLAN profile association table **14***b* (step S**305**).

As described above, the mobile phone terminal **10** does not require such facilities as an entrance/exit managing apparatus or a card reader, and does not necessitate additional functions to be added to the public network; therefore, the mobile phone terminal **10** can be realized with less cost. The mobile phone terminal **10** can be used for a corporate access point or a personal access point and for an access point like a generally used hotspot, without depending on types of the access points. Moreover, it does not require position detection by GPS, and does not consume unnecessary electricity for on/off control of WLAN; therefore, the mobile phone terminal can be realized with less cost and with a simple configuration, providing a significant power saving effect.

In addition, according to the first embodiment, scan operation is stopped by turning off the power source for WLAN when a wireless profile related to terminal position information is not present. Therefore, it is possible to provide a mobile phone terminal that provides a significant power saving effect.

Furthermore, according to the first embodiment, when it becomes out of the WLAN service area from within the service area, the profile is scanned such that the scan operation interval is the shortest in the beginning, and longer thereafter. Besides, the profile is scanned such that the scan operation interval is long from the beginning when the acquired position information is changed and the position information is stored while it is out of the WLAN service area. Therefore, it is possible to optimize the scan operation interval in accordance with the status of the terminal.

In the first embodiment, while position information is registered in the public wireless base station-WLAN profile association table **14***b* for each profile, it is not so limited, and the position information may be registered for each wireless channel.

In the following, a second embodiment is explained with reference to FIGS. **10** to **12**, in which position information is registered in the public wireless base station-WLAN profile association table **14***b* for each wireless channel. FIG. **10** is an example of the public wireless base station-WLAN profile association table **14***b* held by the mobile phone terminal **10***a* according to the second embodiment, FIG. **11** is a diagram for explaining processing of registering position information for each wireless channel, and FIG. **12** is a flowchart of the process of registering the position information for each wireless channel of the mobile phone terminal **10***a* according to the second embodiment.

Described below is an example of the public wireless base station-WLAN profile association table **14***b* held by the mobile phone terminal **10***a* of the second embodiment. As illustrated in FIG. **10**, the public wireless base station-WLAN profile association table **14***b* stores as in the first embodiment position information acquired from a base station, profile names, and wireless channels in the profiles in association with each other. Unlike the first embodiment, registration in the public wireless base station-WLAN profile association table **14***b* according to the second embodiment is performed for each wireless channel.

Specifically, as illustrated in FIG. **11**, although Profile**01** includes 14 channels (ch**1** to ch**14**), actually only Ch**1**, ch**6**, and ch**11** are used in some cases. In such cases, as illustrated in FIG. **11**, when the mobile phone terminal **10***a* according to the second embodiment moves from the WLAN access point of ch**1** to the WLAN access point of ch**6**, the mobile phone terminal **10***a* automatically registers ch**6** in the public wireless base station-WLAN profile association table **14***b*.

With reference to FIG. **12**, the process of registration for each wireless channel performed by the mobile phone terminal **10***a* of the second embodiment is described. The mobile phone terminal **10***a* receives beacon (step S**401**), and determines whether the access point has changed based on the information included in the received beacon (step S**402**). When the access point is determined to have changed as a result, the mobile phone terminal **10***a* calls up the public wireless base station-WLAN profile association table **14***b* (step S**403**).

The mobile phone terminal **10***a* then acquires current position data from the terminal position information (step S**404**), acquires current WLAN profile data (step S**405**), and rewrites data of the public wireless base station-WLAN profile association table **14***b* (registers ch**6** in Profile**01** in the example illustrated in FIG. **12**) (step S**406**).

As described above, only actually used channels are scanned in the second embodiment, and accordingly it is possible to provide a mobile phone terminal providing a more significant power saving effect.

Incidentally, after a mobile phone terminal moves or goes out of a WLAN service area, only profiles and channels registered in a public wireless base station to which a profile used immediately before the mobile phone terminal goes out of the WLAN service area belongs may be scanned.

In the following, the mobile phone terminal **10***b* according to a third embodiment is described with reference to FIGS. **16**

to **18**, in which profiles and channels registered in a public wireless base station to which a profile used immediately before the mobile phone terminal **10***b* goes out of a WLAN service area are scanned. FIG. **16** is a diagram for explaining scan process after the mobile phone terminal **10***b* according to the third embodiment goes out of a WLAN service area, FIG. **17** is a flowchart of an example of scan process after the mobile phone terminal **10***b* of the third embodiment goes or moves out of the WLAN service area. FIG. **18** is a flowchart of another example of scan process after the mobile phone terminal **10***b* of the third embodiment goes out of the WLAN service area.

The scan process after the mobile phone terminal **10***b* goes out of the WLAN service area is described with reference to an example illustrated in FIG. **16**. As illustrated in FIG. **16**, the mobile phone terminal **10***b* performs reverse lookup of a table immediately after it goes out of a WLAN service area, and scans only profiles registered in a public wireless base station to which "Profile**01**" used immediately before it goes or moves out of the WLAN service area belongs (see (**1**) in FIG. **16**).

After a lapse of a predetermined time, the mobile phone terminal **10***b* scans all the profiles (see (**2**) in FIG. **16**). Other than changing profiles to be scanned at two steps as described above, profiles to be scanned may be changed at three steps: only immediately previous "Profile**01**" just after the mobile phone terminal goes out of the WLAN service area; "Profile**01**" and "Profile**02**" registered in the public wireless base station to which Profile**01** belongs; and all the profiles.

The scan process after the mobile phone terminal **10***b* according to the third embodiment goes out of the WLAN service area is described with reference to FIGS. **17** and **18**. FIG. **17** is a flowchart of the scan process in the case of changing profiles to be scanned at two steps. FIG. **18** is a flowchart of the scan process in the case of changing profiles to be scanned at three steps.

Specifically, as illustrated in FIG. **17**, when the mobile phone terminal **10***b* goes out of the WLAN service area, (out of the WLAN service area at step S**601**), the mobile phone terminal **10***b* acquires the WLAN profile used immediately before going out of the WLAN profile (step S**602**), and specifies a public wireless base station associated with the profile acquired from the public wireless base station-WLAN profile association table **14***b* (step S**603**).

The mobile phone terminal **10***b* sets the profile corresponding to the specified public wireless base station as a scan profile for out of the WLAN service area (step S**604**), and sets a timer **1** (step S**605**). The mobile phone terminal **10***b* then determines whether a predetermined time has elapsed with the timer **1** (step S**606**), and if not sets a scan interval (step S**607**).

The mobile phone terminal **10***b* determines whether it is within or out of the WLAN service area (step S**609**), and if within the WLAN service area resets the time **1**, and returns to the processing of the step S**601**, and if out of the WLAN service area repeats the processing of S**606** to S**609** until a lapse of a predetermined time. When the predetermined time has elapsed with the timer **1** (YES at step S**606**), the mobile phone terminal **10***b* increases the scan profile for out of the WLAN service area to all the registered profiles (step S**610**), sets the scan interval (step S**611**), and starts scan operation out of the service area (step S**612**).

Thereafter, the mobile phone terminal **10***b* determines whether it is within or out of the WLAN service area (step S**613**), and if within the WLAN service area resets the timer **1** (step S**614**), and the process returns to the processing at the step S**601**, and if out of the WLAN service area the process returns to the processing of the step S**611** and repeats the processing.

The scan process in the case of changing profiles to be scanned at three steps is described below with reference to FIG. **18**. As illustrated in FIG. **18**, when the mobile phone terminal **10***b* goes out of the WLAN service area (out of the service area at step S**701**), the mobile phone terminal **10***b* sets the timer **1** (step S**702**), determines whether a predetermined time has elapsed (step S**703**), and if not sets a scan interval (step S**704**), and starts scan operation of a profile used immediately before going out of the service area (step S**705**). The mobile phone terminal **10***b* determines whether it is within or out of the WLAN service area (step S**706**), and if within the WLAN service area returns to the processing at the step S**701**, and if out of the WLAN service area repeats the processing at the steps S**703** to S**706** until an elapse of the predetermined time.

When the predetermined time has elapsed with the timer **1** (step S**703**), the mobile phone terminal **10***b* sets a timer **2** (step S**707**), and determines whether a predetermined time has elapsed with the timer **2** (step S**708**). When the predetermined time has not elapsed after setting the timer **2** (NO at step S**708**), the mobile phone terminal **10***b* calls up the scan profile when out of the WLAN service area (step S**709**), sets a scan interval (step S**710**), and starts scan operation out of the service area (step S**711**).

The mobile phone terminal **10***b* then determines whether it is within or out of the WLAN service area (step S**712**), and if within the WLAN service area returns to the processing at the step S**701**, and if out of the WLAN service area repeats the processing at the steps S**708** to S**712** until a lapse of the predetermined time.

On the other hand, when the predetermined time has elapsed after setting the timer **2** (YES at step S**708**), the mobile phone terminal **10***b* increases the scan profile for the time out of the WLAN service area to all the registered profiles (step S**713**), sets a scan interval (step S**714**), and starts the scan operation out of the service area (step S**715**).

Thereafter, the mobile phone terminal **10***b* determines whether it is within or out of the WLAN service area (step S**716**), and if within the WLAN service area returns to the processing at the step S**701**, and if out of the WLAN service area repeats the processing of the steps S**714** to S**716** until a lapse of the predetermined of time.

As described above, according to the third embodiment, immediately after the mobile phone terminal **10***b* goes out of the WLAN service area, only the profiles and the channels registered in the public wireless base station to which the profile used immediately before the mobile phone terminal **10***b* goes out of the WLAN service area belongs are scanned; therefore, it is possible to provide a mobile phone terminal having an improved responsiveness of re-connection when the mobile phone terminal returns to the WLAN service area immediately after it has gone out of the WLAN service area and providing a significant power saving effect.

Moreover, scan profiles to be scanned are changed in accordance with an elapse of time. For example, immediately after the mobile phone terminal goes out of the WLAN service area, a profile used immediately before is scanned because the possibility of the mobile phone terminal returning to the same WLAN service area is high. After a lapse of a predetermined time, all the profiles are scanned because it cannot be known to which WLAB service area the mobile phone terminal returns. Accordingly, it is possible to provide a mobile phone terminal having an improved responsiveness of re-connection and providing a significant power saving effect.

Although in the first to third embodiments, a WLAN profile set as the scan profile is described as being scanned only when it is out of the WLAN service area, it is not so limited. Even within the WLAN service area, if the reception intensity is equal to or lower than a predetermined threshold, the set WLAN profile may be scanned.

That is, with a conventional mobile phone, as illustrated in FIG. **21**, not only when located outside the WLAN-AP service area (out of the WLAN service area), but also when it is within the WLAN service area, if an electric field intensity is equal to or lower than a predetermined threshold (in other words, if the electric field intensity is between A and B in an example illustrated in FIG. **21**), scan operation of searching for a next access point is performed at an interval of about 5 seconds while the mobile phone is in communication. The conventional mobile phone ends up scanning all the registered profiles.

With a mobile phone terminal **10***c* according to the fourth embodiment, as illustrated in FIG. **22**, not only when located outside the WLAN service area, but also when it is within the WLAN service area and the electric field intensity is equal to or lower than a predetermined threshold, only a WLAN profile set as the scan profile is scanned, and the number of profiles to be scanned is optimized. The mobile phone terminal **10***c* according to the fourth embodiment is explained below. The same process as described previously in the first to the third embodiments is omitted.

A specific example of FIG. **22** is explained. Electric field intensity "A" indicated in FIG. **22** is a reception intensity level at which there is an access point currently in connection, and scan operation of searching for another access point is started. Electric field intensity "B" indicated in FIG. **22** is a reception intensity level at which communication with an access point currently in connection can no longer be maintained.

With the mobile phone terminal **10***c* of the fourth embodiment, the electric field intensity "A" is set as the first threshold, and the electric field intensity "B" is set as the second threshold. The mobile phone terminal **10***c* scans only a profile stored therein in association with a base station to which a current WLAN profile belongs when the reception intensity level becomes equal to or lower than the reception intensity level "A".

The mobile phone terminal **10***c* scans only a WLAN profile set as the scan profile for out of the WLAN service area when the reception intensity level becomes equal to or lower than the reception intensity level "B" (when it is out of the WLAN service area) similarly to the first to the third embodiments.

Operation of scanning the WLAN service area performed by the mobile phone terminal **10***c* of the fourth embodiment is described with reference to FIG. **23**. FIG. **23** is a flowchart of scan process when reception intensity of the mobile phone terminal **10***c* according to the fourth embodiment becomes equal to or lower than a threshold.

As illustrated in FIG. **23**, the mobile phone terminal **10***c* determines whether the reception intensity from a wireless LAN access point is equal to or lower than the first threshold (corresponding to the reception intensity level "A" in an example illustrated in FIG. **22**) (Step S**801**). As a result, when the mobile phone terminal **10***c* determines that the reception intensity from the wireless LAN access point is equal to or lower than the first threshold, it acquires a current WLAN profile (Step S**802**), and specifies a public wireless base station associated with a profile acquired from a public wireless base station-WLAN profile association table (Step S**803**).

The mobile phone terminal **10***c* sets a profile associated with the specified public wireless base station as the scan profile for the time of searching for a WLAN-AP (Step S**804**).

Then, the mobile phone terminal **10***c* determines whether the reception intensity from the wireless LAN access point is equal to or lower than the second threshold (corresponding to the reception intensity level "B" in the example illustrated in FIG. **22**) (Step S**805**).

As a result, when the mobile phone terminal **10***c* determines that the reception intensity from the wireless LAN access point is not equal to or lower than the first threshold, it sets a scan interval (Step S**806**), and performs operation of scanning within a service area for searching for a next wireless LAN access point while the mobile phone terminal **10***c* is in communication (Step S**807**).

The mobile phone terminal **10***c* determines whether it is within or out of the WLAN service area (Step S**808**). When it is out of the WLAN service area, the process returns to Step S**807**, and repeats operation of scanning within the service area, and when it is within the WLAN service area, the process returns to Step S**801**, and the process explained above is repeated.

On the other hand, when the mobile phone terminal **10***c* determines that the reception intensity from the wireless LAN access point is equal to or lower than the first threshold at Step S**805**, it sets a timer **1** (Step S**809**). Then, the mobile phone terminal **10***c* determines whether a predetermined time has elapsed with the timer **1** (Step S**810**), and if not, sets a scan interval (Step S**811**) and performs operation of scanning within a service area (Step S**812**).

The mobile phone terminal **10***c* determines whether it is within or out of the WLAN service area (Step S**813**). When it is within the WLAN service area, the mobile phone terminal **10***c* resets the timer **1** (Step S**818**), and the process returns to Step S**801**. When it is out of the WLAN service area, the process of Steps S**810** to S**813** is repeated until a predetermined time elapses.

When a predetermined time has elapsed with the timer **1** at Step S**810**, the mobile phone terminal **10***c* expands the scan profile for the time out of the WLAN service area to all the registered profiles (Step S**814**), sets a scan interval (Step S**815**), and starts operation of scanning outside the service area (Step S**816**).

Thereafter, the mobile phone terminal **10***c* determines whether it is within or out of the WLAN service area (Step S**817**). When it is within the WLAN service area, the mobile phone terminal **10***c* resets the timer **1** (Step S**818**), and the process returns to Step S**801**. When it is out of the WLAN service area, the process returns to Step S**815**, and the process explained above is repeated.

As can be seen, according to the fourth embodiment, the mobile phone terminal **10***c* scans only a WLAN profile set as the scan profile, not only when it is out of the WLAN service area, but also when it is within the WLAN service area, and the electric field intensity is equal to or lower than a predetermined threshold, and optimizes the number of scanned profiles. Accordingly, the mobile phone terminal **10***c* need not perform scan process of searching for a next access point, while the mobile phone terminal **10***c* is in communication, on all the profiles, and can provide a significant power saving effect.

When reception intensity from a wireless LAN access point becomes equal to or lower than a threshold, the mobile phone terminal **10***c* scans only a profile stored in association with a base station to which a wireless LAN profile used immediately before lowering of the reception intensity of the wireless LAN access point belongs. Accordingly, a mobile phone terminal with enhanced reconnection response, and a significant power saving effect can be provided.

While a specific embodiments have been described, other embodiments or modifications are also possible. In the following, such embodiments are explained.

Of the processes described above, all or part of the processes described as being performed automatically may be performed manually, or all or part of the processes described as being performed manually may be performed automatically with a known method. The processing procedures, the control procedures, specific names, and information including various data and parameters described above and illustrated in the drawings may be arbitrarily changed as required unless otherwise specified.

The constituent elements described above are functionally conceptual, and need not be physically configured as illustrated. In other words, the specific mode of dispersion and integration of the constituent elements is not limited to the ones illustrated in the drawings, and the constituent elements, as a whole or in part, may be divided or integrated either functionally or physically based on various types of loads or use conditions. All or any part of the processing functions performed by the devices may be realized by a central processing unit (CPU) and a program analyzed and executed by the CPU, or may be realized as hardware by wired logic.

The wireless communication terminal control method explained in the embodiments may be realized by executing a computer program on a computer such as a personal computer or a workstation. The computer program may be distributed through a network such the Internet. The computer program may also be stored in a computer-readable storage medium, such as a hard disk, flexible disc (FD), compact disc-read only memory (CD-ROM), magnetic optical disk (MO), and digital versatile disk (DVD), and may be read from the medium and executed by a computer.

As set forth hereinabove, according to an embodiment of the present invention, a terminal does not need such a device as an entrance/exit manager or a card reader, and does not need new functions to be added to a public network. Therefore, the terminal can be realized with low cost. Moreover, it can be used for any type of access points such as those for corporate use or personal use, and for generally used hotspot. Moreover, since it is not necessary to detect a position using GPS, electricity is not unnecessarily consumed for on/off control of WLAN. This realizes a mobile phone terminal with a simple configuration at low cost that achieves power saving.

All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the invention. Although the embodiment(s) of the present inventions have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A wireless communication apparatus comprising:

a first communicator configured to communicate via each of a plurality of base stations, each of the plurality of base stations covers a base station area;

a second communicator configured to communicate via a wireless local area network (LAN) access point that covers a wireless LAN area that overlaps multiple base station areas, the wireless LAN area is smaller than the base station area;

a storage configured to store overlapping information indicating that a first base station area overlaps a wireless LAN area; and

a controller configured to make the second communicator find the wireless LAN access point based on the overlapping information and, when the wireless communication apparatus moves from the first base station area to a second base station area, add additional information to the overlapping information, the additional information indicating that the second base station area overlaps the wireless LAN area.

2. A method of controlling a wireless communication apparatus that includes a first communicator configured to communicate via each of a plurality of base stations, each of the plurality of base stations covers a base station area, a second communicator configured to communicate via a wireless local area network (LAN) access point that covers a wireless LAN area that overlaps multiple base station areas, the wireless LAN area is smaller than the base station area, and a storage configured to store overlapping information indicating that a first base station area overlaps a wireless LAN area, the method comprising:

making the second communicator find the wireless LAN access point based on the overlapping information; and

adding, when the wireless communication apparatus moves from the first base station area to a second base station area, additional information to the overlapping information, the additional information indicating that the second base station area overlaps the wireless LAN area.

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